Fishery Data Series No. 09-03

Harvest, Abundance, Age and Length Characteristics of Razor Clams from Eastern Cook Inlet Beaches, 2004-2008

by

Nicole J. Szarzi

and

Patricia A. Hansen

February 2009

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye to fork	MEF
mideye to tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 09-03

HARVEST, ABUNDANCE, AGE AND LENGTH CHARACTERISTICS OF RAZOR CLAMS FROM EASTERN COOK INLET BEACHES, 2004-2008

by
Nicole J. Szarzi
Alaska Department of Fish and Game,
Division of Sport Fish, Homer
and
Patricia A. Hansen
Alaska Department of Fish and Game,
Division of Sport Fish, Research and Technical Services, Anchorage

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

February 2009

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

Nicole J. Szarzi
Alaska Department of Fish and Game, Division of Sport Fish,
3298 Douglas Place, Homer AK 99603-8027, USA

Patricia A. Hansen
Alaska Department of Fish and Game, Division of Sport Fish
333 Raspberry Road, Anchorage, AK 99518-1599, USA

This document should be cited as:
Szarzi, N. J., and P. A., Hansen. 2009. Harvest, abundance, age and length characteristics of razor clams from eastern Cook Inlet beaches 2004-2008. Alaska Department of Fish and Game, Fishery Data Series No. 09-03, Anchorage.

TABLE OF CONTENTS

Page

LIST OF TABLES ii
LIST OF FIGURES ii
LIST OF APPENDICES ii
ABSTRACT 1
INTRODUCTION 1
OBJECTIVES 2
METHODS 2
Digger Distribution and Harvest by Beach 3
Age and Length Composition and Age Specific Harvest by Beach 5
Abundance Estimation 6
RESULTS 10
Digger Effort and Harvest by Beach 10
Age and Length Composition of the Harvest 10
Razor Clam Abundance 11
DISCUSSION 11
REFERENCES CITED 13
TABLES 17
FIGURES 41
APPENDIX A. DATA FILES 53

LIST OF TABLES

Table **Page**

1. Estimated harvest by beach from eastside Cook Inlet, 1977-2003. 18
2. Percentage of razor clam harvest by beach area from eastside Cook Inlet adjusted by relative harvest success rate, 1977-2003. 19
3. Razor clam digger counts on eastside Cook Inlet beaches, 2004-2008. 20
4. Percentage of razor clam harvest by beach area from eastside Cook Inlet adjusted by relative harvest success rate, 2004-2008. 25
5. Estimated harvests by beach area and participation in the eastside Cook Inlet razor clam fishery, 2004-2007. 26
6. Relative percentage of the harvest and estimated harvest of razor clams on eastside Cook Inlet beaches, 2004-2008. 27
7. Percentage of razor clams by age class sampled 2004-2008. 29
8. Average length at last annuli formation of clams by age class from eastside Cook Inlet beaches, 2004-2008. 30
9. Estimates of total clam harvest[a] (H), exploitable clams (≥80 mm), total abundance (N), and exploitation rate (Exp) with standard errors of razor clams at Ninilchik Beach from Deep Creek to Lehman's. 39
10. Estimates of total clam harvesta (H), exploitable clams (≥80 mm), total abundance (N), and exploitation rate (Exp) with standard errors of razor clams from Tower to A-frame at Clam Gulch Beach. 40

LIST OF FIGURES

Figure **Page**

1. Kenai Peninsula showing eastside Cook Inlet beaches. 42
2. Harvest and participation in the recreational razor clam fishery on eastside Cook Inlet beaches, 1969-2007. 43
3. Average length of razor clams from selected eastside Cook Inlet beaches, 1991-2003. 44
4. Razor clam collection areas used for estimating harvest length and age composition. 45
5. Ninilchik and Clam Gulch beach locations where razor clam abundance is periodically estimated. 46
6. Sampling diagram and layout of Ninilchik Beach used for razor clam abundance estimates. 47
7. Sampling diagram and layout of Clam Gulch Beach used for razor clam abundance estimates. 48
8. Sampling ring and pumping apparatus used for razor clam density estimates. 49
9. Length-at-last-annulus formation for razor clams at Clam Gulch Beach, 2004-2008. 50
10. Average length of razor clams from selected eastside Cook Inlet beaches, 1991-2008. 51

LIST OF APPENDICES

Appendix **Page**

A1. Percentage of razor clams sampled at Clam Gulch Beach by age class, 1969-2008. 54
A2. Percentage of razor clams sampled at Ninilchik Beach by age class, 1974, and 1977–2008. 55
A3. Percentage of razor clams sampled at Oil Pad and Set Net accesses combined by age class, 1985-2008. 56
A4. Percentage of razor clams sampled at Cohoe Beach by age class, 1985-2008. 57

ABSTRACT

Pacific razor clam *Siliqua patula* studies along eastern Cook Inlet were conducted from 2004 to 2008 to estimate clam digger distribution, clam harvest by beach, age and length composition of the harvest, and periodically, clam abundance at Ninilchik and Clam Gulch beaches. In 2004-2008, 59.4% of the average annual harvest came from Ninilchik Beach and 20.0% from Clam Gulch Beach. The highest percentage of annual harvest ever recorded from Ninilchik peaked at 68.1% in 2007, whereas clams harvested from Clam Gulch declined to the lowest level ever recorded at 12.2%. The proportion of the harvest taken at Happy Valley in 2008 was 10.6%, the highest from that location since 1988. The estimated abundance of harvestable-sized (≥80 mm) clams along 5.8 km of Ninilchik, where diggers concentrate, was 1,376,166 clams (SE = 347,580) in 2005. The abundance of harvestable-sized clams along 6.1 km of Clam Gulch, where diggers concentrate, was 1,391,378 clams (SE = 192,506) in 2008. The estimated exploitation rate of clams at Ninilchik in 2005 was 17.7% (SE = 0.04%). An unprecedented disappearance of clams, age-7 and older, occurred in 2005 on the northern portion of the eastside beaches from Cohoe south to Set Net Access, including Clam Gulch. Clams grew more slowly in 2005-2007 on the northern beaches between Cohoe and Set Net Access than in 2004. There was a strong 2001 year class present in all areas sampled.

Key words: Cook Inlet, razor clam, *Siliqua patula*, harvest, participation, abundance, exploitation, age, size-at-age

INTRODUCTION

Pacific razor clams *Siliqua patula* are found in exposed fine to medium grain sandy beaches along the west coast of North America from Pismo Beach, California, to the Bering Sea (Weymouth and McMillan 1931). On eastside Cook Inlet beaches razor clams are usually found between +4.6 and –4.3 ft tides (Szarzi 1991). Growth rates decrease with latitude while maximum size and age increase (Weymouth et al. 1925). Maximum age is generally 5 years on the southern end of their range while the oldest clam aged in Alaska was 18 years (Nickerson 1975). Sexual maturity is related more to size than age and razor clams mature at approximately 100 mm (between their fourth and sixth growing season in Alaska) (Nickerson 1975; Nelson *Unpublished*). Spawning is triggered primarily by temperature (Nelson *Unpublished;* Nickerson 1975). Male and female sexes are separate. Females broadcast 6-10 million eggs into the water where they are fertilized randomly by sperm broadcast from males. Razor clams spawn primarily in July and August in Cook Inlet, but some may spawn earlier in the summer (Nelson *Unpublished*). Larvae drift from 6 weeks to 2 months or more as they metamorphose and then settle to the substrate as juveniles (Szarzi et al. *In prep*).

Beaches on the east side of Cook Inlet provide the largest sport fishery for Pacific razor clams in Alaska (Mills 1979, 1980; 1981a, b, 1982-1994; Howe et al. 1995, 1996; 2001a-d; Walker et al. 2003; Jennings et al. 2004; 2006a; 2006b, 2007; *In prep* a-c). This fishery is confined primarily to 81 km (50 mi) of beach between the Kasilof and Anchor rivers (Figure 1). The Alaska Department of Fish and Game (department) began monitoring the clam population in 1965 after the 1964 earthquake caused subsidence of beaches in the Cook Inlet area.

Initial research to estimate clam harvest included creel surveys, digger distribution surveys, and length-at-age analyses at different beaches (Nelson *Unpublished*). Harvest and participation since 1977 have been estimated in the annual Statewide Harvest Survey (Mills 1979, 1980, 1981a, b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker 2003; Jennings et al 2004, 2006a, b). Surveys are mailed to random households where at least one member obtained an Alaskan sport fishing license.

The razor clam sport fishery developed rapidly beginning in 1972 (Figure 2), likely the result of improved road access to the fishery in the late 1960s. The fishery was fairly stable from 1973 to

2003 with an annual clam harvest between 566,000 and 1,300,000 and digging effort ranging from 22,700 to 47,000 digger-days.

Sport fish use and clam harvest patterns have changed dramatically over the life of the fishery as diggers shift to beaches with the largest clams. Until the mid-1980s the predominant harvest came from Clam Gulch Beach (Clam Gulch) (Table 1). Beginning in 1986 and peaking in 1995, a larger percentage of the harvest was taken at Ninilchik Beach (Ninilchik) (Table 2). The percent harvest taken at Ninilchik steadily declined after 1995. Growth rates increase incrementally from the northern to the southern beaches resulting in clams that are larger at age at Ninilchik than at Clam Gulch (Nelson *Unpublished*; Szarzi et al. *In prep*). A 1995 peak in the harvest at Ninilchik occurred after diggers began shifting there in 1986 to take advantage of the larger clams (Athons 1992; Athons and Hasbrouck 1994; Szarzi et al. *In prep*). The average size of clams in department samples at Ninilchik declined after 1994 (Szarzi et al. *In prep*; Figure 3); likely the result of strong new year classes recruiting to harvestable size. The smaller average size of clams at Ninilchik resulted in diggers shifting their efforts back to Clam Gulch after 1995.

The regulations allow diggers to take the first 60 clams dug per day. This has been the limit since 1962, except from 2000 to spring 2003 when the daily bag limit was lowered to 45 clams because of concerns by local residents that the 60 clam limit encouraged the waste of clams. The possession limit was lowered from three to two daily bag limits in 2000 and is currently 120 clams. Winter conditions such as ice build-up on beaches, cold temperatures, and low tides at night preclude most clam digging from October through February. Razor clams may be encountered on any minus tide, but tides lower than -2.0 ft north of Ninilchik and -3.0 ft on beaches from Ninilchik south are preferred by diggers. On the beaches north of Ninilchik, suitable tides occur about 65 days annually while the southern beaches average about 35 days.

This report presents razor clam stock assessment information in 2004-2008 and includes estimates of clam harvest, age composition of harvested clams and clam abundance.

OBJECTIVES

The project objectives were to estimate:

1. Digger distribution and the number of razor clams harvested at Cohoe, Clam Gulch, Oil Pad Access, Ninilchik, Happy Valley and Whiskey Gulch beaches;
2. The age and length composition and age-specific harvest of razor clams at Cohoe, Clam Gulch, Oil Pad Access and Ninilchik beaches;
3. Abundance of razor clams at Ninilchik and Clam Gulch beaches periodically.

METHODS

The razor clam assessment program primarily estimates clam harvest, age composition of harvested clams, and abundance. Harvest for the entire study area, estimated from the Statewide Harvest Survey, is apportioned among the beaches based on the distribution of clam diggers from aerial counts. The age and length composition of the harvest is estimated from samples collected among four of the six study beaches. Finally, methods have been refined to estimate total abundance on two heavily dug clamming areas at Ninilchik and Clam Gulch beaches.

DIGGER DISTRIBUTION AND HARVEST BY BEACH

The eastside Cook Inlet beaches between the Anchor and Kasilof rivers were divided into six study areas based on beach morphology, razor clam population characteristics, and clam digger distribution. Digger counts were made at these six beaches: Whiskey Gulch, Happy Valley, Ninilchik, Oil Pad Access, Clam Gulch, and Cohoe (Figure 1). Whiskey Gulch includes Anchor River to Happy Creek, Happy Valley includes Happy Creek to Deep Creek, Ninilchik includes Deep Creek to Set Net Access Road, Oil Pad Access extends from Set Net Access Road to the Clam Gulch communication tower, Clam Gulch extends from the Clam Gulch communication tower to where the southern extension of Cohoe Loop Road turns inland away from the bluff. Cohoe is the remaining beach north of Clam Gulch to Cape Kasilof. Set Net Access is a beach access road, located approximately 13.7 km south of the Clam Gulch access road. The Clam Gulch communications tower is approximately 3.2 km south of Clam Gulch beach road.

Ninilchik beach is divided into three sub-beaches: Ninilchik Bar, Deep Creek to Lehman's, and Lehman's to Set Net Access. Clam Gulch is also divided into three sub-beaches: Tower to Bluff, Bluff to A-frame, and A-frame to South Extension, for a total of 10 sample sites. Ninilchik Bar is located off the main beach between Deep Creek and the Ninilchik River and is only available to diggers on foot when the tide is less than -3.0 ft. Lehman's is the first group of set net cabins and are located approximately 5.2 km north of the Ninilchik River. A beach access road is also present at this location. Bluff refers to a section of non-vegetated bluff located approximately 0.4 km south of Clam Gulch. The A-frame is a set net cabin located approximately 1.6 km north of Clam Gulch. Southern Extension of Cohoe Loop Road turns inland away from the bluff approximately 6.4 km north of Clam Gulch.

Aerial digger counts were stratified by tide height into two strata: -1.0 to -2.9 ft tides and -3.0 ft and lower. The number of days between flights was determined by dividing the total number of tides in both strata by the number of tides to be flown in those strata. The first flight was chosen randomly and subsequent surveys were chosen systematically April through mid-August when most harvesting occurred.

The aerial digger counts originated at Anchor River within 15 minutes of low water at Deep Creek/Ninilchik and proceeded north. All people associated with digging activity were included in the count, even those traveling along the beach on all-terrain vehicles. People in highway vehicles and those associated with commercial fishing activities were not included.

Digger counts were adjusted by a relative harvest success rate for each beach based on historic data (Szarzi 1991). Estimates were calculated separately for each stratum and then combined. Success rate of diggers varies by beach, so a crude adjustment for success rate was made to estimate harvest by beach. Harvest success rates (I_b) of 0.5 (Whiskey Gulch, Happy Valley, and Cohoe) or 1.0 (Ninilchik, Set Net Access and Clam Gulch) were assigned to each beach. Digger counts for each beach were multiplied by the harvest success rate to give adjusted digger counts:

$$d_{tbk} = I_b A_{tbk} ; \quad (1)$$

where:

d_{tbk} = the adjusted digger count during flight k on beach b in tidal stratum t;

I_b = the harvest success rate for beach b; and

A_{tbk} = the number of diggers counted during flight k on beach b in tidal stratum t.

Harvest by beach was determined by apportioning the total harvest estimate from the Statewide Harvest Survey (Mills 1979, 1980, 1981a, b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker 2003; Jennings et al 2004, 2006 a, b, 2007; *In prep* a-c;) using the adjusted digger counts per beach. The relative harvest on beach *b* during flight *k* of tidal stratum *t* was estimated as:

$$r_{tbk} = \frac{d_{tbk}}{d_{tk}}; \tag{2}$$

where:

d_{tk} = the total adjusted digger count during flight *k* in tidal stratum *t*;

$= \sum_{b=1}^{n} d_{tbk}$; and

n = the total number of beaches.

The average relative harvest on beach *b* in tidal stratum *t* ($\bar{r}_{tb}$) was estimated, incorporating the sample weights (w_{tk}) that adjust the proportions for different total numbers of diggers during different flights:

$$\bar{r}_{tb} = \frac{\sum_{k=1}^{c_t} w_{tk} r_{tbk}}{c_t}; \tag{3}$$

where:

w_{ik} = the sample weight of flight *k* in tidal stratum *t*,

$= \frac{d_{tk}}{\bar{d}_t}$;

$\bar{d}_t = \frac{\sum_{k=1}^{c_t} d_{tk}}{c_t}$; and

$c_{i\,t}$ = the number of flights taken in tidal stratum *t*.

The number of diggers is probably related to the height of the minus tides. Because tide heights run in cycles and selection of flights was systematic and not random, numbers of diggers (sample weights) were probably cyclic. Therefore, a successive difference estimator (Wolter 1985) was used to estimate the variance of the average number of diggers ($\bar{r}_{tb}$):

$$\hat{V}[\bar{r}_{tb}] = \left\{1 - \frac{c_t}{m_t}\right\} \left\{ \frac{\sum_{k=2}^{c_t} \left(w_{tk} r_{tbk} - w_{tb(k-1)} r_{tb(k-1)}\right)^2}{2c_t^2 (c_t - 1)} \right\}; \quad (4)$$

where:

m_t = the number of tides in tidal stratum *t*.

The average relative harvest on beach *b* ($\bar{r}_b$) was then estimated by incorporating stratum weights (w_t) that adjust the proportions for different numbers of tides and different average numbers of diggers in each tidal stratum:

$$\bar{r}_b = \sum_{t=1}^{2} w_t \bar{r}_{tb} \; ; \quad (5)$$

where:

$\bar{w}_t$ = the weight for tidal stratum *t*,

$$= \frac{m_t \bar{d}_t}{\sum_{t=1}^{2} m_t \bar{d}_t}.$$

The estimated harvest for beach *b* ($\hat{H}_b$) is:

$$\hat{H}_b = \bar{r}_b \hat{H} \; ; \quad (6)$$

where $\hat{H}$ is the estimated harvest of razor clams between Anchor Point and Kasilof from the Statewide Harvest Survey (e.g., Jennings et al. *In prep*-b).

Its variance is estimated following Goodman 1960:

$$\hat{V}[\hat{H}_b] = \bar{r}_b^2 \hat{V}[\hat{H}] + \hat{H}^2 \hat{V}[\bar{r}_b] - \hat{V}[\hat{H}] \hat{V}[\bar{r}_b]; \quad (7)$$

where $\hat{V}[\hat{H}]$ is the variance of the Statewide Harvest Survey estimate, and

$$\hat{V}[\bar{r}_b] = \sum_{t=1}^{2} \hat{W}_t^2 \hat{V}[\bar{r}_{tb}].$$

AGE AND LENGTH COMPOSITION AND AGE SPECIFIC HARVEST BY BEACH

Age and length composition of the razor clam harvest has been estimated for Cohoe, Clam Gulch, Oil Pad Access, and Ninilchik beaches since 1977 (Nelson *Unpublished*). Szarzi (1991) recommended collecting 300 ageable clams per beach to estimate age composition and mean length-at-age for the major age classes. Age and length composition of the harvest was estimated from clams hand dug at these four beaches. Sampling was designed to mimic an average clam digger by collecting clams throughout the beach area, rather than sampling from a small specific area. All clams dug were retained, regardless of size or condition, in compliance with state regulation.

For age and length composition and specific harvest by beach, samples were taken at Cohoe from the southern end of the beach. Clam Gulch samples were collected between 1/4 mile south and 1/2 mile north of the Clam Gulch Beach Road (Figure 4). Oil Pad Access was sampled with half of the specimens obtained from the northern end and the other half obtained from the southern end of the beach near Set Net Access Road. Half of the Ninilchik samples were collected within 1 mile north of the Ninilchik River and the other half were collected within 1 mile south of the Ninilchik River. Additional clams were taken from Ninilchik Bar for possible future studies.

To ensure the target sample size of 300 clams was available to estimate age, total length, and length-at-age, 350 clams were collected from each beach to compensate for breakage during processing. At Ninilchik Bar, the goal was to collect 175 total clams. Clams dug on the subsections of beach were kept separate. Only one shell was required from each clam for measuring and aging. Total length was measured as closely as possible from clams that were broken and could not be aged. Clams were processed for aging by removing the body from the shell and bleaching the specimens to remove the periostracum (i.e., the shell's outermost layer). Shells were soaked in a 25% or 50% household bleach solution depending on shell size until most of the periostracum was removed, but the heavy annuli layers remained. Shells less than 80 mm TL were soaked in the 25% bleach solution to prevent over-bleaching. The bleach solution was then poured off, and the shells rinsed in water and dried for aging and measuring. Total length and length at each annulus was measured and input directly into an Excel spreadsheet using Mitutoyo Digimatic Calipers.

Shell aging followed the methods described by Nelson (*Unpublished*) and the recommendations of Coggins (1994). Agers practiced with a test set of previously aged clams until they achieved 60% agreement with the test set shell ages. Upon achieving the desired aging accuracy, aging of the current age sample commenced.

Age was determined for each shell in the sample at least twice. Each shell reading was independent: after determining age for the entire sample, the shells were rearranged and age determined a second time without knowledge of the previously assigned age. If both shell readings agreed, age composition was estimated using the assigned age. If two shell readings were different, those shells were aged again.

ABUNDANCE ESTIMATION

Razor clam abundance was estimated in areas at Ninilchik and at Clam Gulch where the most digging occurs (Figure 5). To estimate the number of clams at the Ninilchik and Clam Gulch study areas, the study area at each beach was stratified into 15.2 m (50 ft) strips parallel to the shoreline (Figures 6 and 7). Transects were established perpendicular to the shoreline across these strips, with one site on a transect in each strip starting at the gravel edge located high up on the beach and extending out to the extreme low tide line. A site is a rectangular area 5.53 m long by 0.79 m wide. Two to seven 0.5 m^2 circular plots were sampled at each site. Abundance was estimated for each stratum independently with a two-stage sampling design. The primary units were sites and the secondary units were plots within a site.

Transect locations were randomly chosen within beach sections at Ninilchik (Figure 6). The first site at Ninilchik to be sampled along the transect was also chosen randomly within the first 15.2 m (50 ft) strip and sites were chosen systematically every 15.2 m thereafter along the transect as far

as the tide allowed. The first sample site at Clam Gulch was chosen randomly and all subsequent sites were chosen systematically both parallel and perpendicular to the shoreline (Figure 7).

Sampling equipment used for the 0.5 m^2 plots consisted of a 4-cycle, 4.0 hp Honda pump with 30 m of cotton fire hose on the outlet (output) side and 7.6 m of stiff plastic hose on the inlet (intake) side (Figure 8). The outlet hose had a metal tube or "wand" attached to direct water flow into the substrate enclosed by a 0.5 m^2 sampling ring. The sampling equipment and techniques used are described in greater detail by Szarzi (1991).

Samples were collected by repeatedly inserting the wand into the substrate inside the sample ring as far as the wand would penetrate. The substrate enclosed in the sample ring was emulsified such that all clams rose to the surface. Sampling continued for 3 minutes or until the entire area within the ring had been loosened and clams no longer surfaced. A hand-held net with 2 mm mesh was used to strain the loosened substrate to capture small clams. All clams collected were measured and released. The goal was to sample seven plots on the ebb tide at each site before moving 15.2 m to the next site along a transect. If all the plots were not dug as the tide ebbed, the remaining plots at each beach site were sampled as the incoming tide flooded the beach. Distance from the gravel's edge along with the number of clams and the length of each clam from each plot was recorded.

The Ninilchik study area was divided into two areas: a 4.2 km (2.6 mi) area north of the Ninilchik River and a 1.6 km (1.0 mi) area south of the river. The southern area was further divided into three equal sections and the northern area into five equal sections. At Ninilchik, 8-10 transects were sampled. At least one transect was sampled in each section and when additional sample days were available, randomly selected northern sections were sampled with an additional transect.

Transects north of the Ninilchik River were located by measuring the distance from where the beach access road enters the beach at Lehman's Point south to a chosen random starting point for the transect using a vehicle odometer. Transects south of the Ninilchik River were located by driving south from the pilings, found at the high tide line, approximately 182 m (200 yd) south of the Ninilchik River, to a random starting point.

Transects at Ninilchik were typically a minimum of 122 m (400 ft) and a maximum of 467 m (1,500 ft) in length. Number of plots sampled per site and transect length were dependent on the tidal range, the rate at which the tide fell, and the beach substrate. The transects north of the Ninilchik River commonly extended from 122 m to 320 m (400 ft to 1,050 ft) with 6 to 19 sites sampled. The beach area north of the river has a steeper gradient than the area south of the river, and less beach area was available for sampling. The three transects south of the Ninilchik River generally extended from 305 m to 456 m (1,000 ft to 1,500 ft) with 16 to 28 sites sampled. To allow comparison among years, abundance estimates for Ninilchik included only the first 183 m (600 ft) of sections north of the river and 396 m (1,300 ft) south of the river. The total beach area was 1,399,231 m^2 (15,061,197 ft^2).

The Clam Gulch study area was approximately 10.3 km (6.4 mi) long and extended from 3.2 km (2.0 mi) north of the Clam Gulch Beach Access Road to approximately 7.1 km (4.4 mi) south of the access road. The study area was divided into 8 equal-sized sections approximately 1,287 m wide. The location of the first site was determined by the intersection of two randomly chosen points; the first being a point along a 1,280 m line parallel to the shoreline and the second being a point chosen along a 15 m line perpendicular to the shoreline. Subsequent samples were taken

systematically every 1,287.5 m along the line parallel to the beach (north to south) and every 15.24 m perpendicular to the beach (west to east). One transect was sampled each day at Clam Gulch. The one transect was located by starting where the access road enters the beach and proceeding north or south a given distance. Only transects from the A-frame south to the communications tower, in the comparable aerial survey sub-beaches, were used to estimate exploitation rates.

The beach near Clam Gulch Access Road and to the north of the access road has a slightly shallower gradient than the area to the south, and less beach area is exposed south of the access during low tide. In the past, the transects north of the Clam Gulch Access extended from 305 m to 427 m (1,000 ft to 1,400 ft) with 20 to 28 sites sampled. Most of the transects south of the Clam Gulch Access extended from 46 m to 335 m (150 ft to 1,100 ft) with 3 to 22 sites sampled. In 2008, transects north of the access extended between 213 m to 366 m (700 ft to 1,200 ft) and transects south of the access extended 121 m to 396 m (400 ft to 1,300 ft). To allow comparison among years, abundance estimates for Clam Gulch included only the first 320 m (1,050 ft) of all sections. The total beach area used for abundance estimates was approximately 1,956,963 m^2 (21,064,574 ft^2).

The abundance of clams on a beach was estimated using a two-stage design (Cochran 1977). The estimate was for clams ≥80 mm which are considered exploitable (Szarzi 1991).

The number of clams ≥80 mm in each section was estimated as:

$$\hat{N}_b = S_b \hat{\bar{N}}_b , \tag{8}$$

where:

S_b = the number of possible sites in beach stratum *b*,

$\hat{\bar{N}}_b$ = mean estimated abundance of sites in beach stratum *b*,

$$\hat{\bar{N}}_b = \frac{\sum_{i=1}^{s_b} \hat{N}_{bi}}{s_b} , \tag{9}$$

where:

s_b = the number of sites sampled in beach stratum *b*,

$\hat{N}_{bi}$ = the estimated abundance of clams in site *i*, beach stratum *b*,

$$\hat{N}_{bi} = P_{bi} \hat{\bar{N}}_{bi} , \tag{10}$$

where:

P_{bi} = the number of possible plots at site *i* in beach stratum ,*b*

$\hat{\bar{N}}_{bi}$ = mean estimated abundance of plots in site *i*, beach stratum *b*,

$$\hat{\bar{N}}_{bi} = \frac{\sum_{j=1}^{p_{bi}} \hat{N}_{bij}}{p_{bi}} , \tag{11}$$

where:

$\hat{N}_{bij}$ = the estimated abundance in plot *j*, site *i*, beach stratum *b*,

p_{bi} = the number of plots sampled at site *i* in beach stratum *b*

with the variance of clam abundance estimated as:

$$Var\left[\hat{N}_b\right] = (1 - f_{1b}) S_b^2 \frac{s_{1b}^2}{s_b} + f_{1b}^{-1} P_{bi}^2 \sum_{i=1}^{s_b} \left[(1 - f_{2bi}) \frac{s_{2bi}^2}{p_{bi}} \right], \quad (12)$$

where:

$s_{1b}^2 = \dfrac{\sum_{i=1}^{s_b} \left(\hat{N}_{bi} - \bar{\hat{N}}_b \right)^2}{s_b - 1}$ the variance among sites,

$s_{2bi}^2 = \dfrac{\sum_{j=1}^{p_{hi}} \left(\hat{N}_{bij} - \hat{N}_{bi(j-1)} \right)^2}{p_{bi} - 1}$ the variance among plots within a site,

$f_{1b} = \dfrac{s_b}{S_b}$ the number of sites sampled on a transect relative to the total possible sites, and

$f_{2bi} = \dfrac{p_{bi}}{P_{bi}}$ the number of plots sampled in a site relative to the total possible plots.

The abundance of clams on the entire beach was the sum of the number of clams in each stratum:

$$\hat{N} = \sum_{b=1}^{B} \hat{N}_b \, . \quad (13)$$

The variance of clam abundance on the entire beach was estimated as:

$$V\left(\hat{N}\right) = \sum_{b=1}^{B} V\left(\hat{N}_b\right). \quad (14)$$

For each area where abundance was estimated annual exploitation rate was calculated as:

$$Exp\ Rate = \frac{\hat{H}}{\hat{N}_{\exp}}, \text{ and} \quad (15)$$

$$V\left[Exp\ Rate\right] = V\left[\hat{H} * \frac{1}{\hat{N}_{\exp}} \right] =$$

$$V\left[\hat{H}\right]\left(\frac{1}{\hat{N}_{\exp}} \right)^2 + \left[\frac{1}{\hat{N}_{\exp}^{\,4}} V\left[\hat{N}_{\exp}\right] \right] \hat{H}^2 - V\left[\hat{H}\right] \left[\frac{1}{\hat{N}_{\exp}^{\,4}} V\left[\hat{N}_{\exp}\right] \right] \quad (16)$$

Clam abundance at the seven northern sections of the 6.1 km (3.8 mi) Clam Gulch study area was used to estimate exploitation of all clams in each beach section because these sections encompass a portion of the beach where harvest was estimated from aerial surveys (Clam Gulch tower to Clam Gulch A-frame; Figure 1).

RESULTS

DIGGER EFFORT AND HARVEST BY BEACH

The highest combined digger count for all beaches in a single aerial survey during 2004-2008 was 2,419 on July 22, 2005, and coincided with a –5.0 ft tide (Table 3). A count of 1,367 diggers at Ninilchik on July 3, 2008, was the highest digger count on an individual beach.

The proportion of the annual harvest north of Ninilchik declined during 2004-2008, and the proportion of the harvest from Ninilchik and areas south increased (Table 4). The proportion of the annual harvest from Ninilchik increased each year until 2007, peaking at 68.1% of the annual total, and the harvest from Clam Gulch declined each year until 2007 to 12%. An increasing proportion of the harvest came from Happy Valley, peaking at 10.6% in 2008. Approximately 12% fewer clams came from Oil Pad Access in 2008 than in 2004.

The proportion of the total harvest taken at Ninilchik increased by nearly 24% between 2004 and 2007, and the estimated annual harvest from Ninilchik increased by approximately 10,000 clams (Table 5). The increase in harvest between 2004 and 2007 from Happy Valley and Whiskey Gulch was similar in magnitude to the increase in harvest from Ninilchik. Harvests from the beaches north of Ninilchik (Cohoe, Clam Gulch, and Oil Pad Access) decreased from 2004 to 2007. The largest declines occurred at Clam Gulch and Oil Pad Access. The substantial increase in the proportion of the harvest from Ninilchik was offset by a decrease in the overall harvest, resulting in the maintenance of fairly stable harvests from Ninilchik between 2004 and 2007. The decrease in the overall harvest is largely the result of fewer clams being taken from Clam Gulch and Oil Pad Access. The annual estimated percent of the harvest and harvest from each beach subsection with standard errors is reported in Table 6.

AGE AND LENGTH COMPOSITION OF THE HARVEST

The ages of razor clams in hand-dug samples from eastside Cook Inlet beaches during 2004-2008 range from 1 to 13 years (Table 7). Spawning success of eastside Cook Inlet razor clams is variable; a strong year class typically enters the harvestable-sized population every 3 to 6 years. There was a strong 2001 year class evident at all study beaches that persisted in annual age and length samples at Clam Gulch and Ninilchik through 2008 and Cohoe and Oil Pad/Set Net Access through 2007 (Table 7 and Appendix A).

Age-4 clams were relatively abundant in samples from Oil Pad/Set Net Access and Ninilchik in 2008, whereas age-3 clams were abundant in Cohoe and Clam Gulch samples. This may be from temporal and spatial variation in the recruitment of new clams or from age error (i.e., clams mistakenly aged as 1 year younger or older). Future sampling should indicate whether there were two relatively strong year classes observed in 2008 or if substantial aging error occurred.

Between 2004 and 2005, the public reported a large die-off of older, larger-sized clams at Clam Gulch. This was evident in age and length samples at Cohoe, Clam Gulch, Oil Pad Access, and Set Net Access beaches in 2005-2008 (Tables 7 and 8). Few clams older than age 7 were sampled on these more northerly beaches. Clams in samples from Cohoe south to Set Net

Access grew more slowly between 2005 and 2007 than in 2004 as evident by smaller length-at-last annulus (Table 8) and visual observation of growth on shells. Figure 9 illustrates the smaller size at age of clams dug in 2005-2007 compared to 2004.

RAZOR CLAM ABUNDANCE

Razor clam density was estimated for the heavily dug sections of Ninilchik in 2005 and Clam Gulch in 2008 (Figure 5). The abundance of exploitable-sized clams (≥80 mm) at Ninilchik in 2005 was 1,376,166 (SE = 347,580) (Table 9). The estimate of total clam abundance at Ninilchik in 2005 was 2,504,067 (SE = 481,426). The harvest rate of exploitable-sized clams from Ninilchik in 2005 was 16% and the harvest rate of all clams was 9%.

The abundance of exploitable-sized clams (≥80 mm) at Clam Gulch in 2008 was 1,391,378 (SE = 192,506) and the estimate of total clam abundance was 3,608,278 (SE = 347,627) (Table 10). The 2008 harvest of razor clams from eastside Cook Inlet beaches is not yet available, but is likely similar in magnitude to the 2007 harvest of approximately 350,000 clams. The Clam Gulch harvest in 2008 is likely similar to 2007 because the same proportion (i.e., 6% from Tower to Bluff and Bluff to A-frame) of the total harvest was taken in both 2007 and 2008 (Table 6). The 2008 estimated harvest rate of exploitable-sized clams from the Clam Gulch study area using the 2007 harvest of 40,077 clams from Tower to Bluff and Bluff to A-frame (Table 6) was 3% and the estimated harvest rate of all clams was 1%.

DISCUSSION

The razor clam fishery along the 81 km of eastern Cook Inlet is sustainable and self-regulating. Diggers continued to shift to areas where clams were larger and more abundant and away from areas where clams were fewer and smaller. In 1986-1995, diggers moved from Clam Gulch to Ninilchik to harvest larger clams and then back to Clam Gulch during 1996-2004 (Athons 1992; Athons and Hasbrouck 1994, Szarzi et al. *In prep*). The shift back to Clam Gulch in 1996 occurred when large cohorts of young clams first appeared at Ninilchik Beach. In 2004-2008, the trend reversed again as more diggers moved away from Clam Gulch and back to Ninilchik and, for the first time, moved south of Ninilchik to Whiskey Gulch and Happy Valley. This occurred as older, larger clams died-off at Clam Gulch between 2004 and 2005, and because of slower clam growth and consequently smaller clams between 2005 and 2007.

Digger effort in 2005-2007 declined, but remained within the range of annual participation recorded since the fishery first became popular in 1973 (Figure 2). Harvest also declined, likely the result of low digger success on beaches north of Ninilchik and lower success rates south of Ninilchik where razor clams are more patchily distributed and harder to find. Despite the lack of clams north of Ninilchik and the shift of diggers south, harvest at Ninilchik did not increase substantially during 2004-2007 (Tables 1 and 5). The harvest rate for exploitable-sized clams at Ninilchik in 2005 of 16% was among the lowest estimated (Table 9). Assuming the 2008 harvest was similar to 2007, the harvest rate of clams at Clam Gulch in 2008 was probably less than, or in the range of, rates previously estimated (Table 10).

A frequent response from diggers to the lack of clams or lack of large clams north of Ninilchik was a concern that the resource was overharvested and restrictions were needed. Although this response is understandable, examination of the fishery reveals that restrictions are unnecessary for conservation and would likely have little or no effect.

The exploitation rate of razor clams in most of their 81 km of habitat on eastside Cook Inlet beaches is likely low. This is based upon clam production and harvest rates estimated for the most heavily harvested beaches (Ninilchik and Clam Gulch) and compared to harvests for the other beaches. The time series of abundance estimates from Ninilchik, where harvest has been focused since the mid 1980s, is limited but there is no overall trend to indicate that exploitation rates are negatively affecting recruitment or exploitable abundance in the immediate vicinity.

Clam age compositions generally had a broad range of ages present along all eastside Cook Inlet beaches, except north of Ninilchik, when a die-off of older clams occurred in 2005-2008. New year classes continue to recruit regularly onto all eastside Cook Inlet beaches. The average size of clams in department samples is variable, but generally decreases as strong new year classes recruit into the population as happened in 1997-1999 and 2005 (Figure 10). Although the lack of large older clams and slow growth in clams from beaches north of Ninilchik was substantial, growth rates in 2008 were typical or above average including the growth of new age classes recruiting into the population in 2008.

In some years, strong year classes recruited to all of the study beaches. The synchrony of reproductive success suggests that the eastside Cook Inlet beach razor clam population is influenced by factors on a large scale. The apparent asynchronous spawning success among beaches in some years may be the result of local factors favoring survival in combination with sampling protocol that limits the area that clams are dug to estimate age composition. Little is known about nearshore water circulation patterns that influence transport or settlement patterns of larval razor clams along eastside Cook Inlet beaches. It is likely that the affect of any localized depletion of a beach on future recruitment to that beach, or the surrounding population, may be mitigated by large scale dispersal of larvae along the entire eastside Cook Inlet shoreline.

The razor clam population on eastside Cook Inlet beaches appears resilient to the perturbation that affected growth and abundance in the northern beaches from 2005 through 2007. The substantial increase in diggers on beaches south of Ninilchik highlights the need for monitoring age and length and abundance on additional southern beaches. Ninilchik continues to support a substantial proportion of the razor clam fishery. The lack of clams older than age 7 in age and length samples since 1990 may be a function of harvest pressure or an artifact of smaller sample sizes of clams collected for age determination prior to 1992. Continued monitoring of abundance on Ninilchik is essential to anticipating and responding to future fishery trends.

A graduate study designed to increase our understanding of environmental factors on razor clam recruitment and abundance, and razor clam early life history will begin in spring 2009. One anticipated outcome of this study will be to better recognize the first annulus in clams thereby resolving an important source of aging error and increasing our ability to predict future abundance.

ACKNOWLEDGEMENTS

Many thanks to the people who toiled to dig clams and lug the pump through the mud; rain or shine, early in the morning to late in the afternoon. The stalwart included: Tom Balland, Patrick Houlihan, Robert Begich, Mike Booz, Carol Kerkvliet, Rosie Robinson, Chris Maio, Michael Cartusciello, Joel Markis, Britta Baechler, Brent Fagan, Edan Badajos, Tim Blackmon and many other volunteers, helpers and visiting dignitaries. Previous researchers Dave Nelson and Dave Athons laid the strong foundation that supported the development of this research program.

REFERENCES CITED

Athons, D. E. 1992. Harvest distribution, age composition, density and abundance of razor clams along the eastern beaches of Cook Inlet, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-50, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-50.pdf

Athons, D. E., and J. J. Hasbrouck. 1994. Harvest distribution, age composition, and abundance of razor clams along the eastern beaches of Cook Inlet, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 94-3, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-03.pdf

Cochran, W. G. 1977. Sampling techniques, *third edition*. John Wiley and Sons, New York.

Coggins, L. G., Jr. 1994. Precision of ages estimated from scales for rainbow trout in Bristol Bay, Alaska. Alaska Department of Fish and Game, Fishery Data Series No. 94-26, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-26.pdf

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Howe, A. L., G. Fidler, A. E. Bingham, and M. J. Mills. 1996. Harvest, catch, and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-32.pdf

Howe, A. L., G. Fidler, and M. J. Mills. 1995. Harvest, catch, and participation in Alaska sport fisheries during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-24, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds95-24.pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001a. Revised Edition. Harvest, catch, and participation in Alaska sport fisheries during 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-29 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-29(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001b. Revised Edition. Harvest, catch, and participation in Alaska sport fisheries during 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-25 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-25(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001c. Revised Edition. Participation, catch, and harvest in Alaska sport fisheries during 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-41 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-41(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001d. Participation, catch, and harvest in Alaska sport fisheries during 1999. Alaska Department of Fish and Game, Fishery Data Series No. 01-8, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds01-08.pdf

Jennings, G. B., K. Sundet, and A. E. Bingham. 2007. Participation, catch, and harvest in Alaska sport fisheries during 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-40, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-40.pdf

Jennings, G. B., K. Sundet, and A. E. Bingham. *In prep-a*. Participation, catch, and harvest in Alaska sport fisheries during 2005. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. *In prep-b*. Participation, catch, and harvest in Alaska sport fisheries during 2007. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

REFERENCES CITED (Continued)

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2004. Participation, catch, and harvest in Alaska sport fisheries during 2001. Alaska Department of Fish and Game, Fishery Data Series No. 04-11, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-11.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006a. Participation, catch, and harvest in Alaska sport fisheries during 2002. Alaska Department of Fish and Game, Fishery Data Series No. 06-34, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-34.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006b. Participation, catch, and harvest in Alaska sport fisheries during 2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-44.pdf

Jennings, G. B., K. Sundet, and A. E. Bingham. In prep-c. Participation, catch, and harvest in Alaska sport fisheries during 2006. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1978-1979, Project F-9-11, 20 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-11(20)SW-I-A.pdf

Mills, M. J. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-12(21)SW-I-A.pdf

Mills, M. J. 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-13(22a)SW-I-A.pdf

Mills, M. J. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-13(22b)SW-I-A.pdf

Mills, M. J. 1982. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1981-1982, Project F-9-14, 23 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-14(23)SW-I-A.pdf

Mills, M. J. 1983. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1982-1983, Project F-9-15, 24 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-15(24)SW-I-A.pdf

Mills, M. J. 1984. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1983-1984, Project F-9-16, 25 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-16(25)SW-I-A.pdf

Mills, M. J. 1985. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1984-1985, Project F-9-17, 26 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-17(26)SW-I-A.pdf

Mills, M. J. 1986. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1985-1986, Project F-10-1, 27 (RT-2), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-10-1(27)RT-2.pdf

Mills, M. J. 1987. Alaska statewide sport fisheries harvest report, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-002.pdf

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-052.pdf

Mills, M. J. 1989. Alaska statewide sport fisheries harvest report, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-122.pdf

REFERENCES CITED (Continued)

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-44.pdf

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds91-58.pdf

Mills, M. J. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-40.pdf

Mills, M. J. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds93-42.pdf

Mills, M. J. 1994. Harvest, catch, and participation in Alaska sport fisheries during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-28, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-28.pdf

Nelson, D. C. *Unpublished*. A review of Alaska's Kenai Peninsula east side beach recreational razor clam (*Siliqua patula*, Dixon) fishery, 1965-1980. Alaska Department of Fish and Game, Division of Sport Fish, Soldotna, Alaska.

Nickerson, R. B. 1975. A critical analysis of some razor clam (*Siliqua patula*, Dixon) [sic] populations in Alaska. Alaska Department of Fish and Game, Fisheries Rehabilitation, Enhancement and Development Division, Juneau.

Szarzi, N. J. 1991. Distribution and abundance of the Pacific razor clam, *Siliqua patula* (Dixon), on the east side Cook Inlet beaches. University of Alaska, Fairbanks, M.Sc. thesis, Juneau, Alaska.

Szarzi, N. J., P. A. Hansen, and J. J. Hasbrouck. *In prep*. Harvest, abundance, age and length characteristics of razor clams from eastern Cook Inlet beaches, 1993-2003. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Walker, R. J., C. Olnes, K. Sundet, A. L. Howe, and A. E. Bingham. 2003. Participation, catch, and harvest in Alaska sport fisheries during 2000. Alaska Department of Fish and Game, Fishery Data Series No. 03-05, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-05.pdf

Weymouth, F. W., H. C. McMillan, and H. B. Holmes. 1925. Growth and age at maturity of the Pacific razor clam *Siliqua patula* (Dixon). U. S. Department of Commerce, Bureau of Fisheries Bulletin 41:201-236.

Weymouth, F. W., and H. C. McMillan. 1931. Relative growth and mortality of the Pacific razor clam, (*Siliqua patula*, Dixon) [sic] and their bearing on the commercial fishery. U. S. Government Printing Office. Bureau of Fisheries 1099:543-567.

Wolter, K. M. 1985. Introduction to variance estimation. Springer-Verlag, New York

TABLES

Table 1.-Estimated harvest by beach from eastside Cook Inlet, 1977-2003.

Year	Beach Area						Total Harvest	Participation (Digger-Days)
	Cohoe	Clam Gulch	Oil Pad	Ninilchik	Happy Valley	Whiskey Gulch		
1977	19,072	614,943	97,684	99,545	26,979	13,025	871,247	25,393
1978	15,977	670,079	92,959	61,973	38,733	16,946	896,667	29,750
1979	24,023	745,767	71,025	72,070	45,958	7,834	966,677	30,323
1980	15,206	520,484	63,431	90,368	64,300	17,813	771,603	31,494
1981	13,864	504,833	106,130	91,788	84,617	28,206	829,436	31,298
1982	11,519	477,753	105,494	132,170	177,035	60,022	963,994	31,954
1983	16,854	474,312	125,199	154,091	146,868	61,396	978,720	31,470
1984	9,575	477,568	203,475	210,657	104,730	38,301	1,044,307	29,880
1985	9,312	374,943	187,472	332,731	135,327	28,555	1,068,340	31,195
1986	11,261	284,825	241,108	398,755	149,699	39,081	1,124,728	32,507
1987	1,664	211,890	128,687	508,092	92,632	36,055	979,020	25,427
1988	8,807	306,207	56,906	624,607	131,425	43,357	1,171,308	30,905
1989	1,809	239,697	100,401	419,696	47,487	23,065	832,155	22,658
1990	3,081	289,581	140,579	441,589	56,992	19,154	950,974	29,427
1991	6,792	326,429	158,135	586,115	72,433	16,883	1,166,787	31,899
1992	3,887	249,724	120,247	716,193	58,193	9,520	1,157,765	44,527
1993	2,497	198,993	111,823	585,751	40,877	6,508	946,450	39,927
1994	3,611	250,634	126,788	825,302	50,292	12,505	1,269,131	47,112
1995	1,602	227,924	120,438	752,350	37,051	8,508	1,147,872	41,837
1996	4,453	189,186	110,776	467,529	31,863	9,138	812,946	29,885
1997	4,658	219,530	113,210	465,680	17,932	8,831	829,841	28,343
1998	6,344	182,101	106,749	325,811	15,341	7,266	643,612	26,636
1999	9,177	203,127	100,368	401,960	29,827	6,425	750,883	36,292
2000	18,475	262,153	107,460	402,427	41,542	10,214	842,270	37,755
2001	11,364	231,888	105,152	246,299	22,716	8,308	625,727	31,915
2002	14,861	212,126	132,620	358,290	25,402	14,763	758,062	33,966
2003	7,525	192,567	104,277	226,434	24,736	10,104	565,643	25,120
Mean	9,529	338,491	119,948	370,306	65,592	20,807	924,673	32,181

Note: Harvest and digger days of participation determined by Statewide Harvest Survey (Mills 1979, 1980, 1981a, b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker 2003; Jennings et al. 2004, 2006a, b). Harvest by beach is apportioned from aerial surveys and assumes a success rate of 0.5 on the Cohoe, Happy Valley, and Whiskey Gulch beach areas.

Table 2.-Percentage of razor clam harvest by beach area from eastside Cook Inlet adjusted by relative harvest success rate, 1977-2003.

Year	No. of surveys	Beach Area					
		Cohoe	Clam Gulch	Oil Pad	Ninilchik	Happy Valley	Whiskey Gulch
1977	3	2.2	70.6	11.2	11.4	3.1	1.5
1978	9	1.8	74.7	10.4	6.9	4.3	1.9
1979	8	2.5	77.1	7.3	7.5	4.8	0.8
1980	8	2.0	67.5	8.2	11.7	8.3	2.3
1981	9	1.7	60.9	12.8	11.1	10.2	3.4
1982	6	1.2	49.6	10.9	13.7	18.4	6.2
1983	6	1.7	48.5	12.8	15.7	15.0	6.3
1984	6	0.9	45.7	19.5	20.2	10.0	3.7
1985	5	0.9	35.1	17.5	31.1	12.7	2.7
1986	4	1.0	25.3	21.4	35.5	13.3	3.5
1987	3	0.2	21.6	13.1	51.9	9.5	3.7
1988	3	0.8	26.1	4.9	53.3	11.2	3.7
1989	11	0.2	28.8	12.1	50.4	5.7	2.8
1990	12	0.3	30.5	14.8	46.4	6.0	2.0
1991	10	0.6	28.0	13.6	50.2	6.2	1.5
1992	13	0.3	21.6	10.4	61.9	5.0	0.8
1993	13	0.3	21.0	11.8	61.9	4.3	0.7
1994	13	0.3	19.8	10.0	65.0	4.0	1.0
1995	13	0.1	19.9	10.5	65.5	3.2	0.7
1996	13	0.6	23.3	13.6	57.5	3.9	1.1
1997	12	0.6	26.5	13.6	56.1	2.2	1.1
1998	12	1.0	28.3	16.6	50.6	2.4	1.1
1999	14	1.2	27.1	13.4	53.5	4.0	0.9
2000	13	2.2	31.1	12.8	47.8	4.9	1.2
2001	13	1.8	37.1	16.8	39.4	3.6	1.3
2002	14	2.0	28.0	17.5	47.3	3.4	2.0
2003	13	1.3	34.2	18.8	39.6	4.3	1.7
Average	10	1.1	37.3	13.2	39.4	6.8	2.2

Note: Harvest percentage weighted by tidal height beginning in 1990.

Table 3.-Razor clam digger counts on eastside Cook Inlet beaches, 2004-2008.

2004	Date:	5/6	5/8	5/18	5/21	6/4	6/16	6/20	7/3	7/17	7/29	7/30	8/2
	Tide:	-5.0	-3.4	-1.8	-1.4	-5.5	-1.0	-1.1	-5.3	-5.3	-1.7	-3.1	-4.4
Whiskey Gulch													
Anchor River to Happy Creek		32	33	2	2	70	0	10	120	19	0	17	65
Happy Valley													
Happy Creek to Deep Creek		132	58	3	6	210	7	10	290	11	26	35	18
Ninilchik													
Deep Creek to Set Net Access		483	354	21	10	653	38	20	1,022	113	108	330	423
A. Ninilchik Bar		52	2	0	0	40	0	0	30	0	0	1	5
B. Deep Creek to Lehmans		420	328	21	10	605	38	20	990	113	108	322	415
C. Lehmans to Access		11	24	0	0	8	0	0	2	0	0	7	3
Oil Pad Access													
Set Net Access to Clam Gulch Tower		202	460	20	16	262	13	35	40	67	19	83	55
Clam Gulch													
Tower to S. extension of Cohoe Lp. Rd.		235	480	20	24	416	14	100	550	173	75	104	186
A. Tower to Bluff		140	310	16	14	200	12	65	330	91	29	56	50
B. Bluff to A frame		65	140	4	10	185	2	30	170	73	46	45	120
C. A frame to S. Ext.		30	30	0	0	31	0	5	50	9	0	3	16
Cohoe													
S. extension of Cohoe Lp. Rd to Kasilof R.		26	25	0	0	31	0	5	60	1	0	13	32
Total Diggers		**1,110**	**1,410**	**66**	**58**	**1,642**	**72**	**180**	**2,082**	**384**	**228**	**582**	**779**

-continued-

Table 3.-Page 2 of 5.

2005	Date:	4/26	4/27	5/23	5/25	5/28	6/20	6/21	6/23	7/19	7/20	7/22	8/19	8/21
	Tide:	-3.2	-2.9	-3.1	-4.3	-1.9	-1.8	-3.3	-4.0	-1.4	-3.1	-5.0	-4.0	-4.1
Whiskey Gulch														
Anchor River to Happy Creek		10	2	21	42	46	7	33	101	0	20	171	39	27
Happy Valley														
Happy Creek to Deep Creek		22	11	27	79	72	10	55	160	9	25	357	81	100
Ninilchik														
Deep Creek to Set Net Access		97	55	158	341	298	73	229	657	83	237	971	350	569
A. Ninilchik Bar		1	0	0	2	0	0	1	32	0	9	66	2	9
B. Deep Creek to Lehmans		95	55	158	323	298	71	227	620	83	228	900	348	560
C. Lehmans to Access		1	0	0	16	0	2	1	5	0	0	5	0	0
Oil Pad Access														
Set Net Access to Clam Gulch Tower		28	3	35	90	51	5	39	128	12	43	336	33	21
Clam Gulch														
Tower to S. extension of Cohoe Lp. Rd.		43	21	75	185	232	42	96	282	8	177	580	108	98
A. Tower to Bluff		29	13	49	96	94	25	54	77	4	115	345	55	71
B. Bluff to A frame		12	8	16	71	125	17	37	170	4	57	205	41	19
C. A frame to S. Ext.		2	0	10	18	13	0	5	35	0	5	30	12	8
Cohoe														
S. extension of Cohoe Lp. Rd to Kasilof R.		2	1	0	6	36	2	8	20	0	1	4	1	7
Total Diggers		**202**	**93**	**316**	**743**	**735**	**139**	**460**	**1,348**	**112**	**503**	**2,419**	**612**	**822**

-continued-

Table 3.-Page 3 of 5.

2006	Date:	4/27	5/14	5/26	5/28	5/30	6/13	6/22	6/25	6/28	7/12	7/25	8/9	8/13	9/8
	Tide:	-4.2	-2.5	-3.9	-3.9	-1.9	-3.4	-1	-3	-1.8	-4.1	-2	-3.6	-1.2	-3.3
Whiskey Gulch															
Anchor River to Happy Creek		19	11	61	232	9	63	0	69	14	97	22	21	0	30
Happy Valley															
Happy Creek to Deep Creek		54	13	82	124	7	87	7	93	35	218	61	53	15	37
Ninilchik															
Deep Creek to Set Net Access		141	74	538	927	29	358	35	512	104	793	309	248	87	46
A. Ninilchik Bar		4	0	4	1	0	0	0	5	0	16	0	0	0	0
B. Deep Creek to Lehmans		134	74	530	915	29	352	35	495	104	760	302	244	87	46
C. Lehmans to Access		3	0	4	11	0	6	0	12	0	17	7	4	0	0
Oil Pad Access															
Set Net Access to Clam Gulch Tower		58	6	55	121	0	37	0	56	0	106	40	1	20	1
Clam Gulch															
Tower to S. extension of Cohoe Lp. Rd.		19	75	93	440	4	76	3	134	31	172	65	47	26	6
A. Tower to Bluff		6	36	27	160	0	30	0	58	27	74	34	14	3	2
B. Bluff to A frame		11	32	60	255	4	46	0	72	4	78	29	28	23	4
C. A frame to S. Ext.		2	7	6	25	0	0	3	4	0	20	2	5	0	0
Cohoe															
S. extension of Cohoe Lp. Rd to Kasilof R.		1	8	8	7	0	0	0	16	3	0	0	0	0	0
Total Diggers		**292**	**187**	**837**	**1,851**	**49**	**621**	**45**	**880**	**187**	**1,386**	**497**	**370**	**148**	**120**

-continued-

Table 3.-Page 4 of 5.

2007	Date:	4/19	5/2	5/16	5/17	5/19	6/2	6/13	6/14	6/16	6/18	7/3	7/14	7/16	7/18
	Tide:	-5.3	-1.3	-4.9	-5.4	-4.2	-1.8	-3.3	-4.3	-4.5	-2.7	-2.4	-3.6	-3.2	-1
Whiskey Gulch															
Anchor River to Happy Creek		76	0	56	115	234	18	35	162	230	19	14	108	86	6
Happy Valley															
Happy Creek to Deep Creek		73	3	90	182	278	25	71	123	397	21	62	326	109	28
Ninilchik															
Deep Creek to Set Net Access		225	13	360	528	617	149	80	707	1,377	131	268	835	560	70
A. Ninilchik Bar		5	0	7	12	12	0	0	7	85	0	0	13	21	0
B. Deep Creek to Lehmans		212	13	353	560	590	141	78	700	1,292	131	268	795	537	70
C. Lehmans to Access		8	0	0	6	15	8	2	0	0	0	0	27	2	0
Oil Pad Access															
Set Net Access to Clam Gulch Tower		44	0	25	34	81	0	3	16	45	0	0	79	36	0
Clam Gulch															
Tower to S. extension of Cohoe Lp. Rd.		27	8	33	85	211	38	43	46	197	19	59	76	130	30
A. Tower to Bluff		6	1	15	53	86	19	31	30	97	11	32	44	52	0
B. Bluff to A frame		21	7	15	26	91	19	10	14	83	8	27	24	69	30
C. A frame to S. Ext.		0	0	3	0	34	0	2	2	17	0	0	8	9	0
Cohoe															
S. extension of Cohoe Lp. Rd to Kasilof R.		0	0	4	9	28	4	0	0	17	8	0	4	0	0
Total Diggers		**445**	**24**	**568**	**953**	**1,449**	**234**	**232**	**1,054**	**2,263**	**198**	**403**	**1,428**	**921**	**134**

-continued-

Table 3.-Page 5 of 5.

2008	Date:	4/7	4/20	5/4	5/5	5/9	6/2	6/5	6/7	6/19	6/21	7/3	7/6	7/19	8/2	8/17
	Tide:	-4.3	-1.7	-3.1	-4.6	-3.0	-3.5	-5.4	-3.5	-1.4	-1.3	-5.0	-3.4	-1.7	-4.4	-1.5
Whiskey Gulch																
Anchor River to Happy Creek		36	5	46	77	14	43	130	50	10	11	98	65	23	109	9
Happy Valley																
Happy Creek to Deep Creek		59	26	77	84	6	85	248	125	42	37	345	153	104	309	32
Ninilchik																
Deep Creek to Set Net Access		92	60	243	216	72	224	607	448	92	146	1,367	641	347	933	111
A. Ninilchik Bar		4	1	3	5	0	0	23	7	0	0	6	0	0	12	0
B. Deep Creek to Lehmans		88	59	240	211	72	224	580	440	92	146	1,355	635	330	895	111
C. Lehmans to Access		0	0	0	0	0	0	4	1	0	0	6	6	17	26	0
Oil Pad Access																
Set Net Access to Clam Gulch Tower		4	0	36	43	15	12	36	40	4	4	59	17	22	62	6
Clam Gulch																
Tower to S. extension of Cohoe Lp. Rd.		25	1	48	26	17	25	59	142	28	69	90	144	100	158	18
A. Tower to Bluff		9	0	24	22	15	21	42	61	6	10	44	70	10	38	3
B. Bluff to A frame		16	1	17	4	0	4	14	59	19	59	34	71	90	101	15
C. A frame to S. Ext.		0	0	7	0	2	0	3	22	3	0	12	3	0	19	0
Cohoe																
S. extension of Cohoe Lp. Rd to Kasilof R.		2	0	10	0	0	0	12	5	0	0	0	5	0	31	0
Total Diggers		**218**	**92**	**460**	**446**	**124**	**389**	**1,092**	**810**	**176**	**267**	**1,959**	**1,025**	**596**	**1,602**	**176**

Table 4.-Percentage of razor clam harvest by beach area from eastside Cook Inlet adjusted by relative harvest success rate, 2004-2008.

Year	No. of surveys	Beach Area					
		Cohoe	Clam Gulch	Oil Pad	Ninilchik	Happy Valley	Whiskey Gulch
2004	12	1.2	30.5	16.2	44.8	5.1	2.3
2005	13	0.9	26.4	10.0	53.2	6.3	3.3
2006	14	0.3	18.1	7.4	62.9	6.7	4.6
2007	14	0.5	12.2	3.5	68.1	9.8	6.0
2008	15	0.3	12.7	4.2	68.0	10.6	4.2
Average	14	0.6	20.0	8.3	59.4	7.7	4.1

Table 5.-Estimated harvests by beach area and participation in the eastside Cook Inlet razor clam fishery, 2004-2007.

Year	Beach Area						Total Harvest	Participation (Digger-Days)
	Cohoe	Clam Gulch	Oil Pad	Ninilchik	Happy Valley	Whiskey Gulch		
2004	6,046	154,646	82,032	227,467	25,768	11,664	507,624	29,258
2005	3,653	112,806	42,749	227,089	26,808	13,911	427,016	32,835
2006	1,502	79,528	32,893	276,299	28,354	19,905	438,482	24,474
2007	1,599	42,585	12,141	237,670	34,086	21,099	349,180	25,098
2008	not available							
Mean	3,200	97,391	42,454	242,131	28,754	16,645	430,576	27,916

Note: Harvest and digger days of participation determined by Statewide Harvest Survey (Jennings et al. 2007, *In prep* a-c). Harvest by beach is apportioned from aerial surveys and assumes a success rate of 0.5 on the Cohoe, Happy Valley and Whiskey Gulch beach areas.

Table 6.-Relative percentage of the harvest and estimated harvest of razor clams on eastside Cook Inlet beaches, 2004-2008.

Beach Area	Relative Percent (P_b)	SE (P_b)	Relative Success	Harvest (H)	SE (H)
2004					
Whiskey Gulch	0.02	0.001	0.5	11,664	834
Happy Valley	0.05	0.003	0.5	25,768	2,028
Ninilchik Bar	0.02	0.002	1	8,033	1,231
Deep Creek to Lehman's	0.43	0.014	1	216,037	13,971
Lehman's to Set Net Access	0.01	0.001	1	3,398	392
Oil Pad Access	0.16	0.162	1	82,032	7,691
Tower to Bluff	0.17	0.169	1	85,666	6,025
Bluff to A-Frame	0.11	0.114	1	58,062	3,806
A-Frame to S. Extension of Cohoe Loop	0.02	0.022	1	10,918	723
Cohoe	0.01	0.012	0.5	6,046	424
TOTAL	1.00			507,624	28,061
2005					
Whiskey Gulch	0.03	0.002	0.5	13,911	1,219
Happy Valley	0.06	0.003	0.5	26,808	1,989
Ninilchik Bar	0.01	0.001	1	5,413	490
Deep Creek to Lehman's	0.52	0.015	1	220,171	15,042
Lehman's to Set Net Access	0.00	0.000	1	1,505	228
Oil Pad Access	0.10	0.005	1	42,749	3,299
Tower to Bluff	0.13	0.005	1	57,424	4,076
Bluff to A-Frame	0.11	0.008	1	48,125	4,465
A-Frame to S. Extension of Cohoe Loop	0.02	0.002	1	7,256	830
Cohoe	0.01	0.002	0.5	3,653	754
TOTAL	1.00			427,016	26,315
2006					
Whiskey Gulch	0.05	0.002	0.5	19,905	1,639
Happy Valley	0.07	0.002	0.5	28,354	2,305
Ninilchik Bar	0.00	0.000	1	1,843	260
Deep Creek to Lehman's	0.62	0.009	1	270,293	19,721
Lehman's to Set Net Access	0.01	0.001	1	4,162	369
Oil Pad Access	0.07	0.004	1	32,893	3,143
Tower to Bluff	0.07	0.005	1	32,112	3,082
Bluff to A-Frame	0.10	0.004	1	42,474	3,675
A-Frame to S. Extension of Cohoe Loop	0.01	0.001	1	4,942	565
Cohoe	0.00	0.001	0.5	1,502	284
TOTAL	1.00			438,482	31,223

-continued-

Table 6.-Page 2 of 2.

Beach Area	Relative Percent (P_b)	SE (P_b)	Relative Success	Harvest (H)	SE (H)
2007					
Whiskey Gulch	0.06	0.002	0.5	21,099	1,660
Happy Valley	0.10	0.003	0.5	34,086	2,648
Ninilchik Bar	0.02	0.001	1	5,418	623
Deep Creek to Lehman's	0.66	0.008	1	229,495	16,815
Lehman's to Set Net Access	0.01	0.001	1	2,756	426
Oil Pad Access	0.03	0.001	1	12,141	981
Tower to Bluff	0.06	0.003	1	19,747	1,729
Bluff to A-Frame	0.06	0.005	1	20,329	2,244
A-Frame to S. Extension of Cohoe Loop	0.01	0.001	1	2,509	289
Cohoe	0.00	0.001	0.5	1,599	301
TOTAL	1.00			349,180	25,271
2008					
Whiskey Gulch	0.04	0.001	0.5	Not available	
Happy Valley	0.11	0.002	0.5	Not available	
Ninilchik Bar	0.01	0.001	1	Not available	
Deep Creek to Lehman's	0.67	0.006	1	Not available	
Lehman's to Set Net Access	0.01	0.001	1	Not available	
Oil Pad Access	0.04	0.002	1	Not available	
Tower to Bluff	0.04	0.003	1	Not available	
Bluff to A-Frame	0.08	0.005	1	Not available	
A-Frame to S. Extension of Cohoe Loop	0.01	0.001	1	Not available	
Cohoe	0.00	0.000	0.5	Not available	
TOTAL	1.00				

Table 7.-Percentage of razor clams by age class sampled 2004-2008.

Ninilchik	Age Class													Number
	1	2	3	4	5	6	7	8	9	10	11	12	13	Sampled
2004		1.0	**54.5**	15.7	8.4	8.7	7.4	2.3	1.3	0.3	0.3		0.3	299
2005	1.0	23.1	7.7	**49.8**	7.4	2.0	4.3	1.7	1.0	0.7	0.7	0.7		299
2006		1.3	23.3	8.5	**53.1**	7.5	3.0	2.6	0.3	0.3				305
2007		20.9	17.4	38.0	8.1	**14.2**	1.4							345
2008		8.1	42.7	19.3	18.7	1.9	**9.0**		0.3					321

Set Net and Oil Pad accesses combined	Age Class													Number
	1	2	3	4	5	6	7	8	9	10	11	12	13	Sampled
2004			**43.9**	14.5	10.2	7.9	9.6	8.6	5.3					303
2005		5.2	10.0	**70.6**	11.8	1.4	1.0							289
2006		8.4	44.0	6.4	**37.2**	3.4	0.7							298
2007		20.7	21.7	37.9	8.4	**10.4**	1.0							309
2008		8.6	40.6	22.4	24.1	1.0	**3.0**	0.3						303

Clam Gulch	Age Class													Number
	1	2	3	4	5	6	7	8	9	10	11	12	13	Sampled
2004			**1.3**	8.9	16.5	20.1	13.2	27.1	10.2	2.0	0.7			303
2005		5.7	7.7	**47.5**	20.1	4.0	6.4	3.3	5.4					299
2006		0.7	10.3	4.3	**60.9**	15.3	7.1	0.4	0.4	0.4	0.4			281
2007		1.0	14.5	21.0	4.8	**54.5**	2.3	1.6	0.3					310
2008		2.6	11.5	35.8	19.5	1.3	**25.9**	2.9	0.3	0.3				313

Cohoe	Age Class													Number
	1	2	3	4	5	6	7	8	9	10	11	12	13	Sampled
2004			**3.3**	35.5	30.9	9.9	11.2	7.2	2.0					152
2005			2.0	**80.0**	14.0	2.7	1.3							150
2006		0.6	25.9	10.1	**48.7**	14.6								158
2007			33.8	37.6	8.3	**18.5**	1.9							157
2008		2.5	20.6	56.9	16.9	0.6	**2.5**							160

Note: Bold numbers indicate 2001, a strong year class evident at all study beaches.

Table 8.-Average length at last annuli formation of clams by age class from eastside Cook Inlet beaches, 2004-2008.

	Cohoe	Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured			5	54	47	15	17	11	3				
	Average length			**62.36**	**79.67**	**97.60**	**103.49**	**109.70**	**114.15**	**114.19**				
	SE (length)			1.96	5.31	5.62	3.82	5.63	6.69	6.67				
2005	Number measured			3	120	21	4	2						
	Average length			**49.75**	**69.06**	**85.12**	**97.37**	**109.00**						
	SE (length)			5.39	8.75	7.04	3.47	5.71						
2006	Number measured		1	41	16	77	23							
	Average length		**23.13**	**45.71**	**63.03**	**75.03**	**86.66**							
	SE (length)			3.32	3.03	6.08	5.96							
2007	Number measured			53	59	13	29	3						
	Average length			**49.42**	**65.81**	**76.48**	**80.81**	**88.08**						
	SE (length)			4.09	4.47	4.92	6.17	6.91						
2008	Number measured		4	33	91	27	1	4						
	Average length		**29.70**	**50.04**	**65.98**	**76.17**	**89.06**	**88.60**						
	SE (length)		2.58	4.99	5.93	4.41		3.68						

-continued-

Table 8.-Page 2 of 9.

Clam Gulch		Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured			4	25	51	62	40	82	31	6	2		
	Average length			**49.87**	**77.62**	**95.76**	**103.83**	**107.12**	**113.09**	**115.86**	**118.30**	**121.02**		
	SE (length)			7.07	6.67	7.63	7.58	7.14	5.68	6.34	7.40	13.70		
2005	Number measured		17	23	142	60	12	19	10	15				
	Average length		**23.80**	**45.72**	**59.49**	**81.24**	**97.79**	**107.92**	**111.27**	**109.87**				
	SE (length)		3.67	7.38	6.88	8.81	10.56	7.97	7.94	5.27				
2006	Number measured		2	29	12	171	43	20	1	1	1	1		
	Average length		**18.63**	**43.37**	**56.73**	**68.07**	**85.36**	**98.11**	**109.65**	**113.71**	**107.58**	**104.94**		
	SE (length)		2.34	7.40	6.11	7.67	8.36	7.67						
2007	Number measured		3	45	65	15	169	7	5	1				
	Average length		**25.19**	**42.97**	**58.03**	**64.83**	**74.43**	**86.62**	**80.06**	**118.81**				
	SE (length)		7.02	4.91	6.41	6.56	8.08	6.36	6.36					
2008	Number measured		8	36	112	61	4	81	9	1	1			
	Average length		**34.76**	**49.83**	**63.73**	**71.71**	**77.79**	**83.49**	**94.48**	**98.27**	**100.83**			
	SE (length)		3.98	6.43	6.39	5.41	5.91	6.12	5.43					

-continued-

Table 8.-Page 3 of 9.

Set Net Access		Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured			98	33	13	3	2	2	1				
	Average length			**84.87**	**102.71**	**111.94**	**113.90**	**128.79**	**128.16**	**122.88**				
	SE (length)			5.79	8.66	5.48	10.48	6.26	2.74					
2005	Number measured		7	1	119	15	1	1						
	Average length		**43.00**	**74.83**	**92.96**	**111.24**	**123.32**	**128.26**						
	SE (length)		5.34		5.44	5.70								
2006	Number measured		8	53	15	70	2							
	Average length		**47.54**	**72.40**	**86.02**	**99.48**	**109.97**							
	SE (length)		10.05	5.55	6.08	5.22	5.20							
2007	Number measured		58	23	36	17	18	3						
	Average length		**47.81**	**69.79**	**87.29**	**97.50**	**102.53**	**105.92**						
	SE (length)		4.44	5.53	4.78	4.96	6.13	7.64						
2008	Number measured		23	87	30	20	2							
	Average length		**55.04**	**81.95**	**94.35**	**103.70**	**111.74**							
	SE (length)		8.04	5.78	5.40	6.89	1.01							

-continued-

Table 8.-Page 4 of 9.

Oil Pad Access		Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured			35	11	18	21	27	24	15				
	Average length			**65.63**	**92.18**	**101.76**	**111.92**	**116.44**	**119.37**	**122.98**				
	SE (length)			10.18	8.10	6.74	6.11	6.52	7.89	6.09				
2005	Number measured		8	28	85	19	3	2						
	Average length		**33.21**	**58.76**	**79.14**	**98.82**	**109.98**	**118.12**						
	SE (length)		4.51	6.44	6.48	7.45	3.89	0.43						
2006	Number measured		17	78	4	41	8	2						
	Average length		**35.21**	**53.56**	**67.24**	**79.78**	**89.25**	**105.13**						
	SE (length)		5.04	6.01	1.49	7.37	6.76	0.68						
2007	Number measured		6	44	81	9	15							
	Average length		**36.05**	**54.03**	**70.21**	**79.44**	**85.06**							
	SE (length)		3.55	6.10	5.66	2.97	4.78							
2008	Number measured		3	36	38	53	1	9	1					
	Average length		**44.31**	**61.27**	**74.53**	**81.76**	**87.35**	**94.55**	**101.02**					
	SE (length)		4.81	5.31	5.23	5.19		6.62						

-continued-

Table 8.-Page 5 of 9.

Set Net and Oil Pad accesses		Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured			133	44	31	24	29	26	16				
	Average length			**79.8**	**100.1**	**106.0**	**112.2**	**117.3**	**120.0**	**123.0**				
	SE (length)			11.1	9.6	8.0	6.5	7.1	8.0	5.9				
2005	Number measured		15	29	204	34	4	3						
	Average length		**37.78**	**59.31**	**87.20**	**104.30**	**113.32**	**121.50**						
	SE (length)		6.92	6.99	9.01	9.12	7.39	5.87						
2006	Number measured		25	131	19	111	10	2						
	Average length		**39.15**	**61.18**	**82.06**	**92.20**	**93.39**	**105.13**						
	SE (length)		8.99	10.95	9.54	11.31	10.72	0.68						
2007	Number measured		64	67	117	26	32	3						
	Average length		**46.71**	**59.44**	**75.47**	**91.25**	**94.59**	**105.92**						
	SE (length)		5.55	9.55	9.57	9.77	10.39	7.64						
2008	Number measured		26	123	68	73	3	9	1					
	Average length		**53.80**	**75.90**	**83.28**	**87.77**	**103.61**	**94.55**	**101.02**					
	SE (length)		8.42	11.00	11.23	11.36	14.10	6.62						

-continued-

Table 8.-Page 6 of 9.

Ninilchik Bar		Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured		64	20	9	4	35	5	2	11	1		1	
	Average length		**84.38**	**100.69**	**116.12**	**124.95**	**129.56**	**132.91**	**130.46**	**138.85**	**140.31**		**159.23**	
	SE (length)		6.57	4.86	7.62	4.14	5.39	4.41	6.32	6.48				
2005	Number measured		48	19	49	6	4	3	1		1			
	Average length		**49.99**	**79.71**	**103.84**	**116.55**	**118.25**	**131.93**	**130.51**		**145.10**			
	SE (length)		8.19	9.08	5.75	5.84	15.13	5.74						
2006	Number measured			87	20	33	3	1	1					
	Average length			**77.93**	**95.36**	**112.95**	**119.92**	**128.79**	**121.90**					
	SE (length)			5.81	6.82	7.48	3.48							
2007	Number measured		22	41	69	13	22	4	1					
	Average length		**48.18**	**73.42**	**101.90**	**112.80**	**122.93**	**127.78**	**139.63**					
	SE (length)		7.51	8.90	5.13	6.43	4.35	3.09						
2008	Number measured		2	60	23	51	7	27	1					
	Average length		**51.66**	**85.89**	**100.08**	**115.09**	**119.35**	**127.98**	**134.58**					
	SE (length)		12.57	6.90	6.98	7.15	3.24	5.00						

-continued-

Table 8.-Page 7 of 9.

Ninilchik North		Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured		2	86	15	7	16	14	6	2	1			1
	Average length		**53.84**	**93.74**	**106.40**	**118.54**	**127.49**	**134.09**	**134.14**	**141.66**	**130.67**			**147.41**
	SE (length)		20.76	5.25	7.21	5.58	4.84	4.02	5.04	3.19				
2005	Number measured		17	11	94	10	4	11	3					
	Average length		**51.67**	**84.47**	**106.91**	**117.27**	**128.12**	**133.08**	**138.62**					
	SE (length)		8.18	6.69	5.64	4.69	10.38	4.42	5.22					
2006	Number measured		3	33	14	87	6	5	1					
	Average length		**50.63**	**80.25**	**86.42**	**109.60**	**120.04**	**128.76**	**132.12**					
	SE (length)		8.40	5.57	18.83	10.67	1.33	7.19						
2007	Number measured		43	37	52	17	34	2						
	Average length		**52.55**	**83.59**	**99.13**	**115.51**	**119.27**	**126.10**						
	SE (length)		4.86	6.31	5.17	5.75	5.32	3.86						
2008	Number measured		2	84	35	23	1	16						
	Average length		**55.36**	**87.40**	**103.87**	**113.32**	**117.25**	**126.36**						
	SE (length)		2.91	5.57	8.26	6.20 .		4.45						

-continued-

Table 8.-Page 8 of 9.

	Ninilchik South	Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured		1	77	32	18	8	8	1	2				
	Average length		**55.84**	**90.81**	**106.35**	**112.48**	**128.30**	**137.28**	**143.70**	**140.61**				
	SE (length)			7.09	9.05	8.90	10.94	7.63		6.46				
2005	Number measured	3	52	12	55	12	2	2	2	3	2	2	2	
	Average length	**7.02**	**53.07**	**86.81**	**107.88**	**119.79**	**130.50**	**133.50**	**144.00**	**140.49**	**138.72**	**144.94**	**148.02**	
	SE (length)	5.09	10.49	14.97	6.81	6.23	9.01	3.56	1.06	5.98	5.00	9.10	24.94	
2006	Number measured		1	38	12	75	17	4	7	1	1			
	Average length		**49.57**	**86.10**	**103.81**	**120.28**	**128.54**	**127.12**	**129.54**	**140.18**	**129.32**			
	SE (length)			6.92	6.50	4.81	4.87	3.83	2.83					
2007	Number measured		29	23	79	11	15	3						
	Average length		**49.97**	**86.02**	**103.38**	**108.14**	**123.72**	**128.94**						
	SE (length)		8.48	7.50	6.88	10.54	8.10	3.53						
2008	Number measured		24	53	27	37	5	13		1				
	Average length		**40.98**	**83.89**	**103.73**	**116.76**	**118.20**	**127.62**		**137.54**				
	SE (length)		8.10	5.71	6.13	5.41	5.36	6.40						

-continued-

Table 8.-Page 9 of 9.

Ninilchik North and South		Age Class												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2004	Number measured		3	163	47	25	26	22	7	4	1			1
	Average length		**54.51**	**92.36**	**106.36**	**114.17**	**127.80**	**135.25**	**135.51**	**141.13**	**130.67**			**147.41**
	SE (length)		14.73	6.34	8.43	8.46	7.57	5.65	5.85	4.20				
2005	Number measured	3	69	23	149	22	6	13	5	3	2	2	2	
	Average length	**7.02**	**52.73**	**85.69**	**107.26**	**118.64**	**128.92**	**133.14**	**140.77**	**140.49**	**138.72**	**144.94**	**148.02**	
	SE (length)	5.09	9.93	11.57	6.09	5.60	9.07	4.16	4.75	5.98	5.00	9.10	24.94	
2006	Number measured		4	71	26	162	23	9	8	1	1			
	Average length		**50.37**	**83.38**	**94.45**	**114.54**	**126.33**	**128.03**	**129.86**	**140.18**	**129.32**			
	SE (length)		6.88	6.94	16.77	10.00	5.68	5.67	2.77					
2007	Number measured		72	60	131	28	49	5						
	Average length		**51.51**	**84.52**	**101.69**	**112.61**	**120.63**	**127.80**						
	SE (length)		6.63	6.84	6.57	8.61	6.55	3.52						
2008	Number measured		26	137	62	60	6	29		1				
	Average length		**42.09**	**86.05**	**103.81**	**115.44**	**118.04**	**126.92**		**137.54**				
	SE (length)		8.72	5.86	7.35	5.92	4.81	5.34						

Table 9.-Estimates of total clam harvest[a] (H), exploitable clams (≥80 mm), total abundance (N), and exploitation rate (Exp) with standard errors of razor clams at Ninilchik Beach from Deep Creek to Lehman's.

Population	Year	H	SE(H)	N	SE(N)	Exp	SE(Exp)
Total	1989[a]	334,389	18,139	1,922,958	291,507	0.174	0.028
	1990	321,354	26,342	2,497,119	415,512	0.129	0.024
	1991	354,583	20,952	2,284,160	363,719	0.155	0.026
	1992	563,709	24,690	3,751,812	997,854	0.150	0.040
	1998	287,423	15,845	1,517,748	128,088	0.189	0.019
	2001	219,972	12,371	1,442,316	148,842	0.153	0.018
	2003	210,385	14,293	4,387,196	648,139	0.048	0.008
	2005	220,171	15,042	2,504,067	481,426	0.088	0.018
Exploitable	1989[a]	334,389	18,139	559,252	113,278	0.598	0.125
	1990	321,354	26,342	741,462	202,179	0.433	0.123
	1991	354,583	20,952	2,128,979	355,182	0.167	0.029
	1992	563,709	24,690	3,645,057	1,002,100	0.155	0.043
	1998	287,423	15,845	964,109	170,445	0.298	0.055
	2001	219,972	12,371	832,451	116,180	0.264	0.040
	2003	210,385	14,293	1,532,484	335,507	0.137	0.031
	2005	220,171	15,042	1,376,166	347,580	0.160	0.042

Note: Abundance and exploitation rate estimates and their standard errors are corrected from previous publications.

[a] Harvest estimated as the product of the proportion of average total beach harvest that occurred in 1990-1999 in the smaller beach area and the average harvest of the entire beach in 1990-1999.

Table 10.-Estimates of total clam harvest (H), exploitable clams (≥80 mm), total abundance (N), and exploitation rate (Exp) with standard errors of razor clams from Tower to A-frame at Clam Gulch Beach.

Beach	Year	H	SE(H)	N	SE(N)	Exp	SE(Exp)
Total	1988[a]	286,375	14,646	7,240,569	999,223	0.040	0.005814
	1989[a]	224,173	11,465	8,093,750	540,227	0.028	0.002327
	1999	185,144	10,286	9,191,769	587,435	0.020	0.001704
	2008[b]	40,077		3,608,278	347,627	0.011	
Exploitable	1988[a]	286,375	14,646	2,463,695	607,132	0.116	0.029218
	1989[a]	224,173	11,465	4,773,362	371,752	0.047	0.004372
	1999	185,144	10,286	4,052,949	217,262	0.046	0.003524
	2008[b]	40,077		1,391,378	192,506	0.029	

Note: Abundance and exploitation rate estimates and their standard errors are corrected from previous publications that contained estimates for a larger beach area.

[a] Harvest estimated as the product of the proportion of average total beach harvest that occurred in 1990-1999 in the smaller beach area and the average harvest of the entire beach in 1990-1999.

[b] Harvest estimated from 2007.

FIGURES

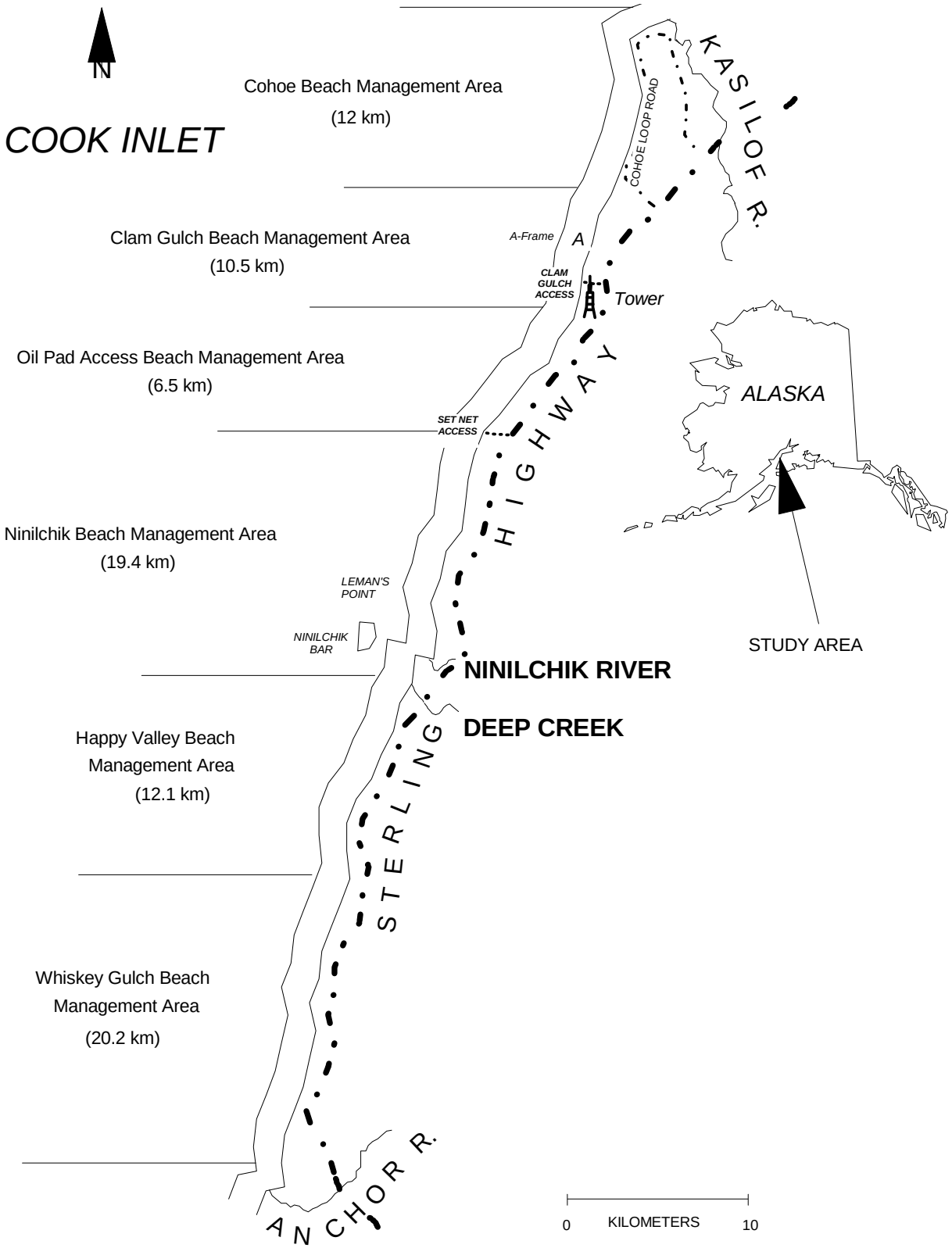

Figure 1.-Kenai Peninsula showing eastside Cook Inlet beaches.

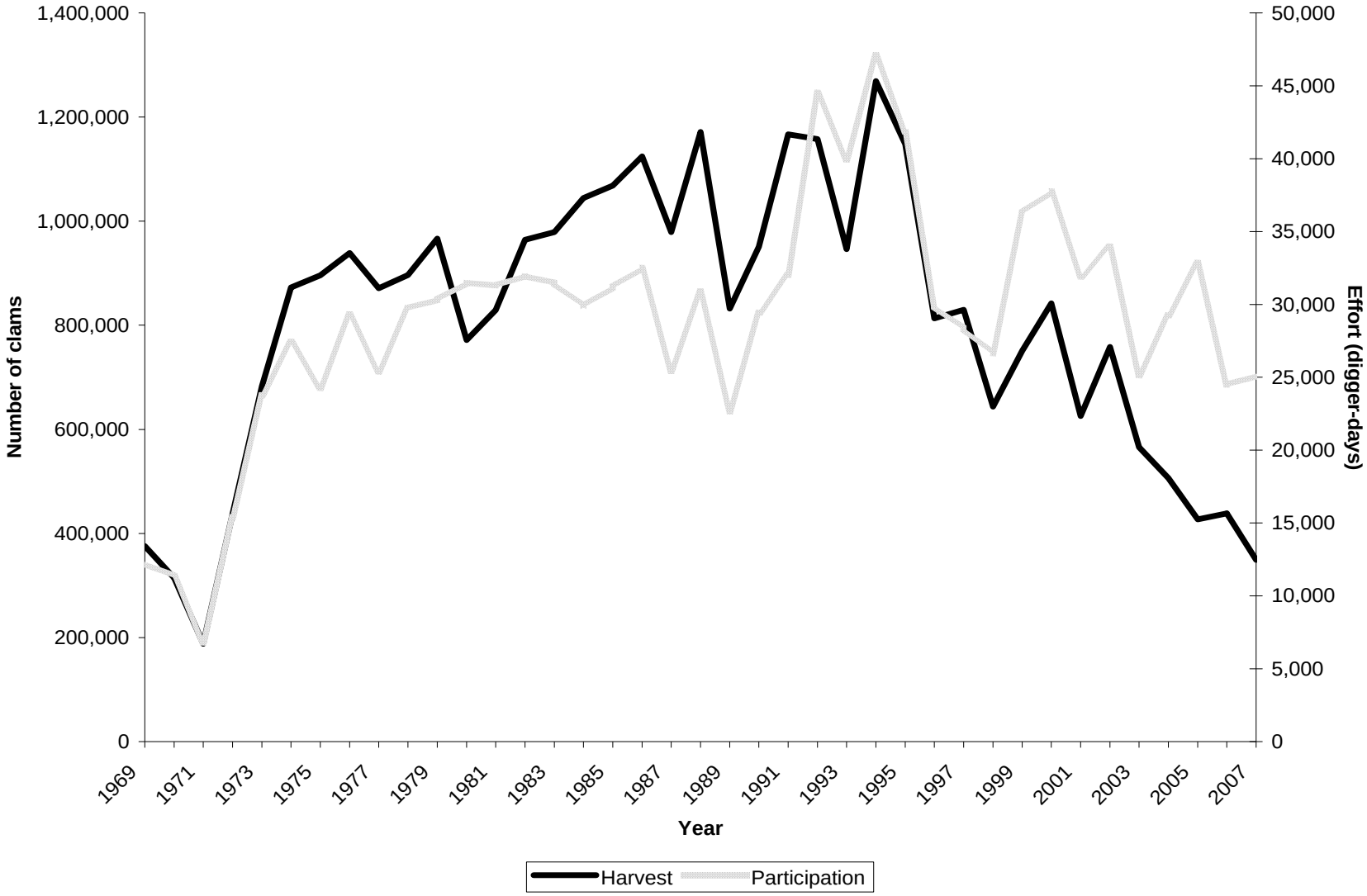

Figure 2.-Harvest and participation in the recreational razor clam fishery on eastside Cook Inlet beaches, 1969-2007.

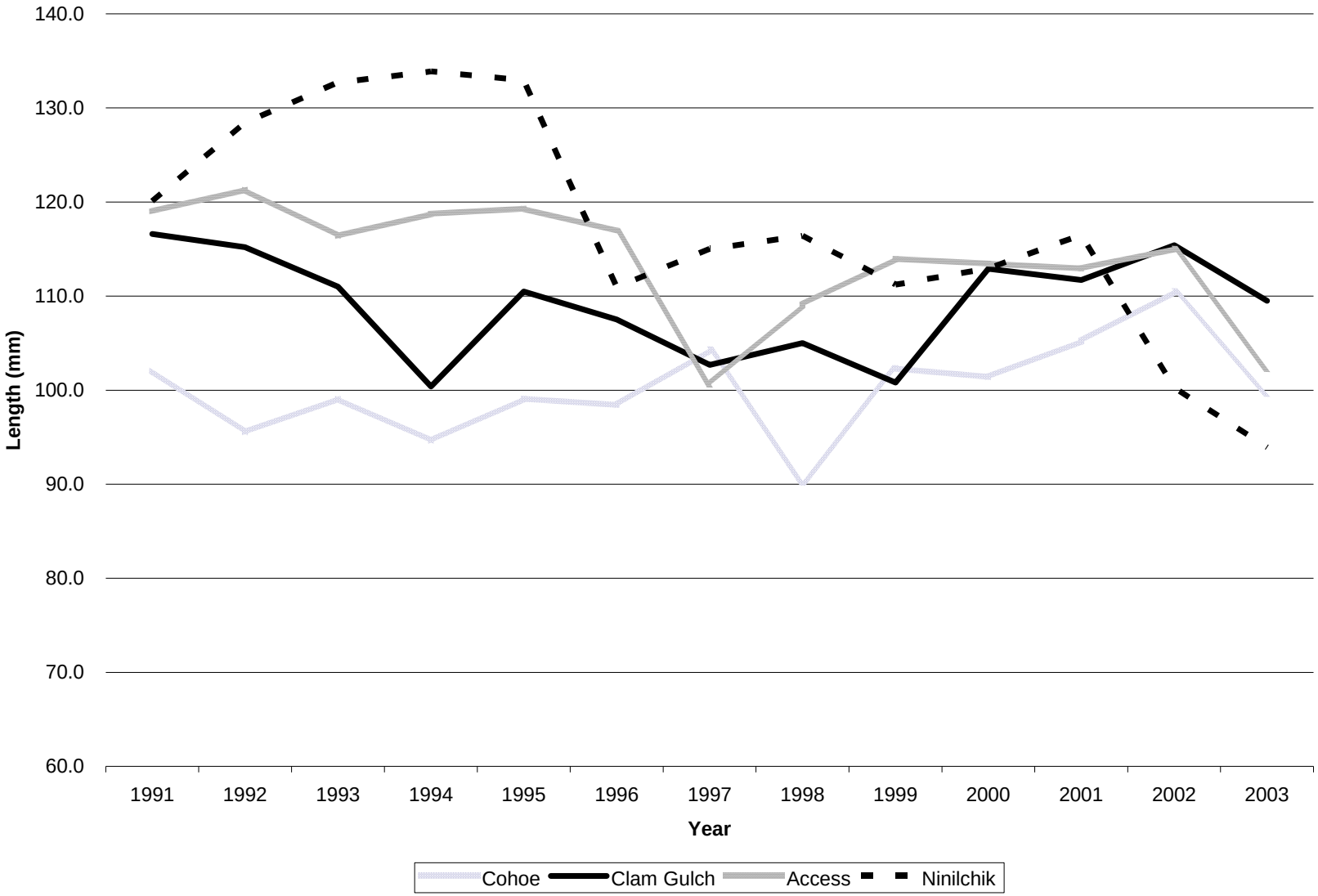

Figure 3.-Average length of razor clams from selected eastside Cook Inlet beaches, 1991-2003.

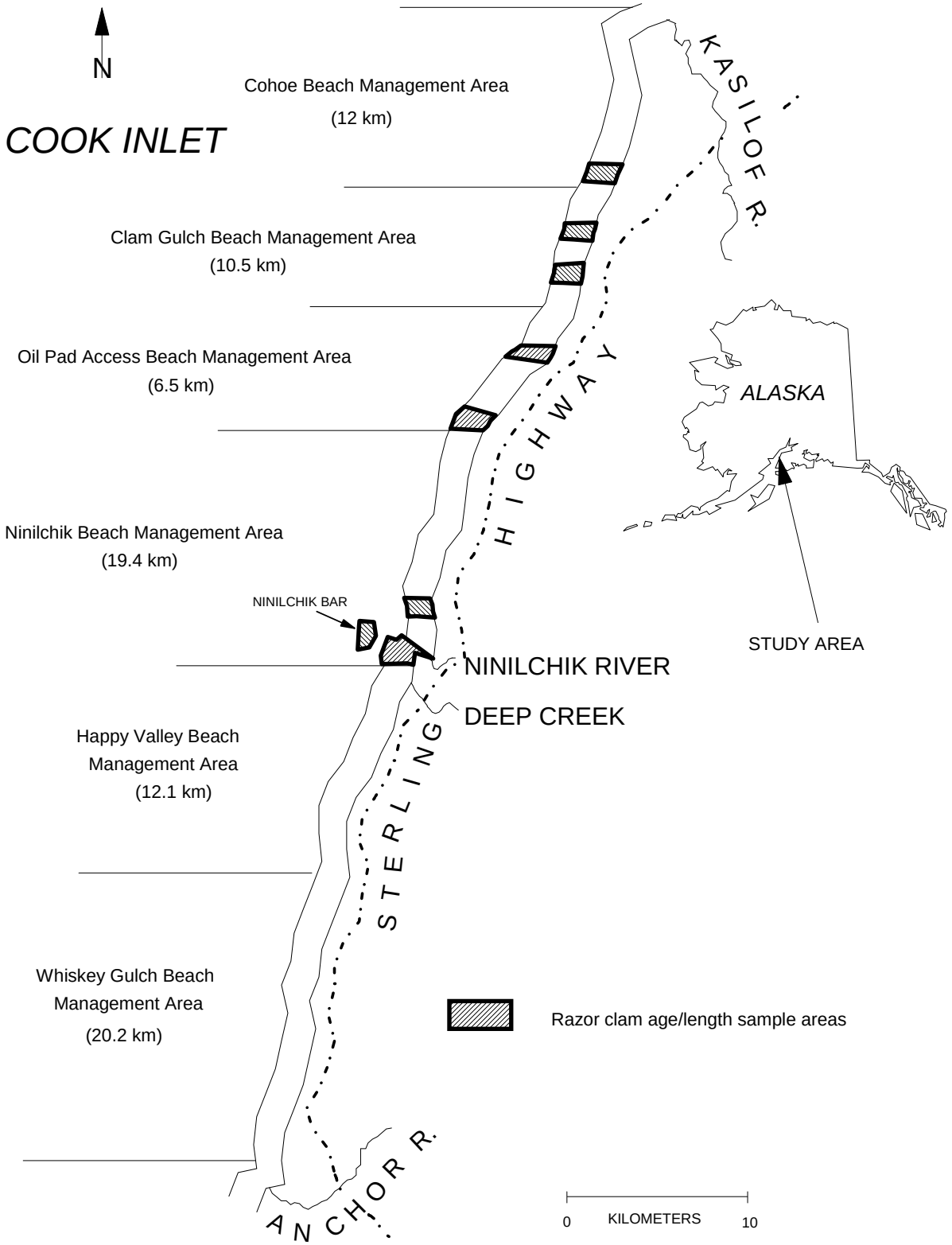

Figure 4.-Razor clam collection areas used for estimating harvest length and age composition.

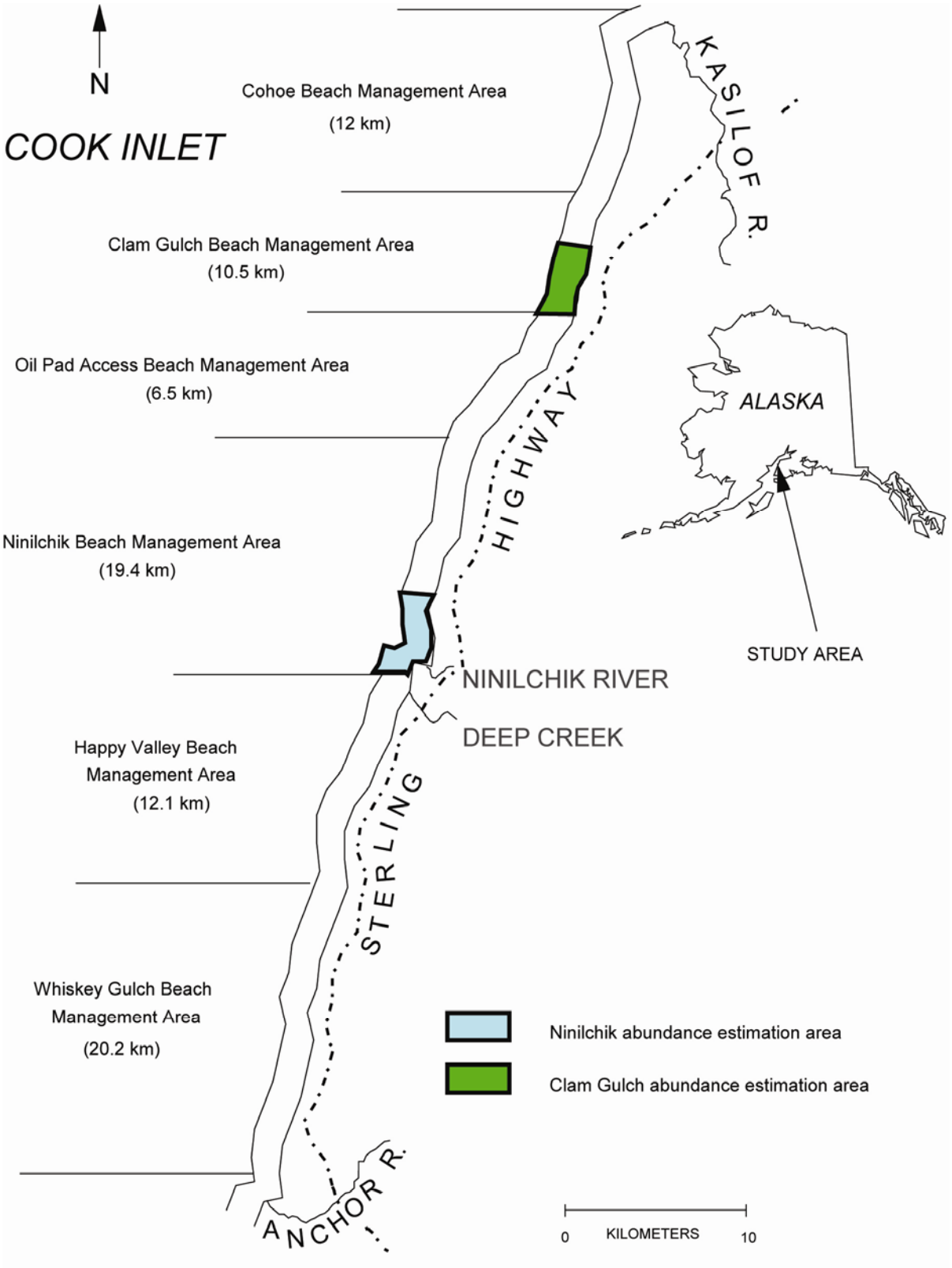

Figure 5.-Ninilchik and Clam Gulch beach locations where razor clam abundance is periodically estimated.

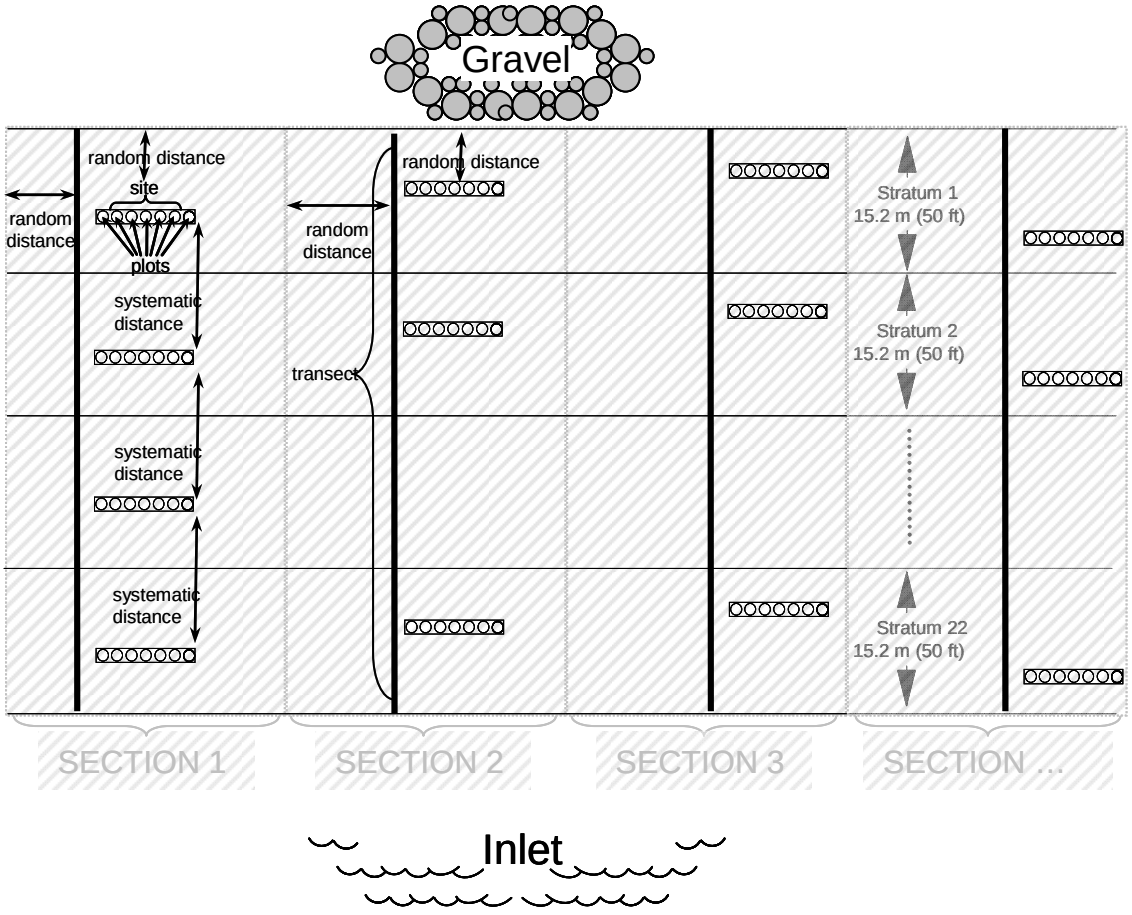

Figure 6.-Sampling diagram and layout of Ninilchik Beach used for razor clam abundance estimates.

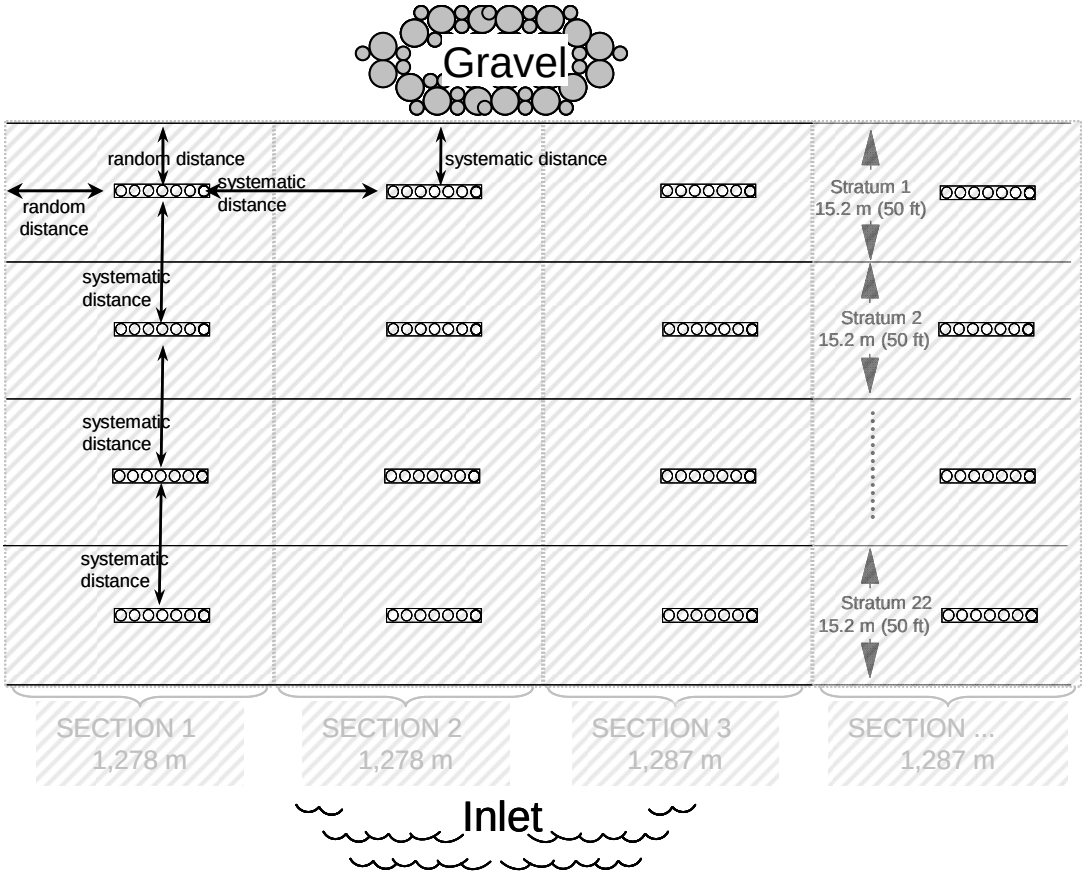

Figure 7.-Sampling diagram and layout of Clam Gulch Beach used for razor clam abundance estimates.

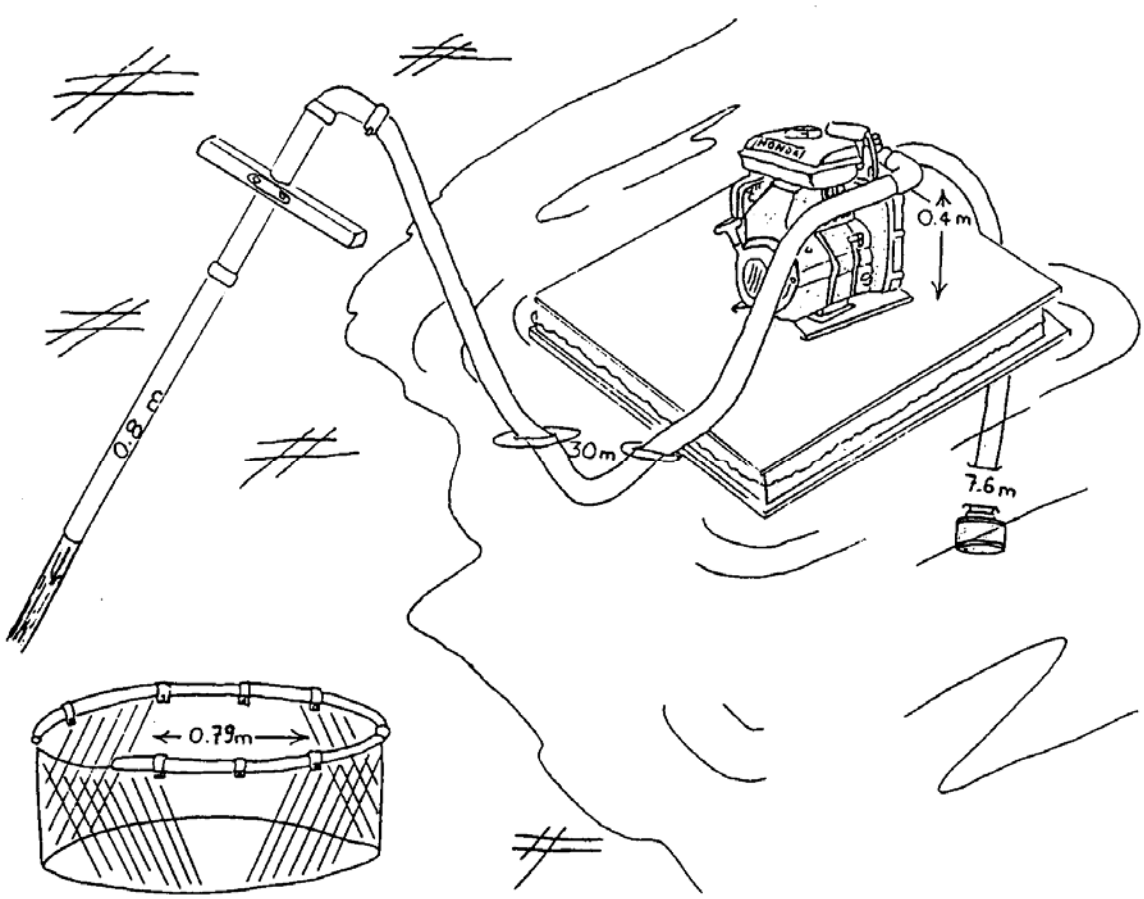

Figure 8.-Sampling ring and pumping apparatus used for razor clam density estimates.

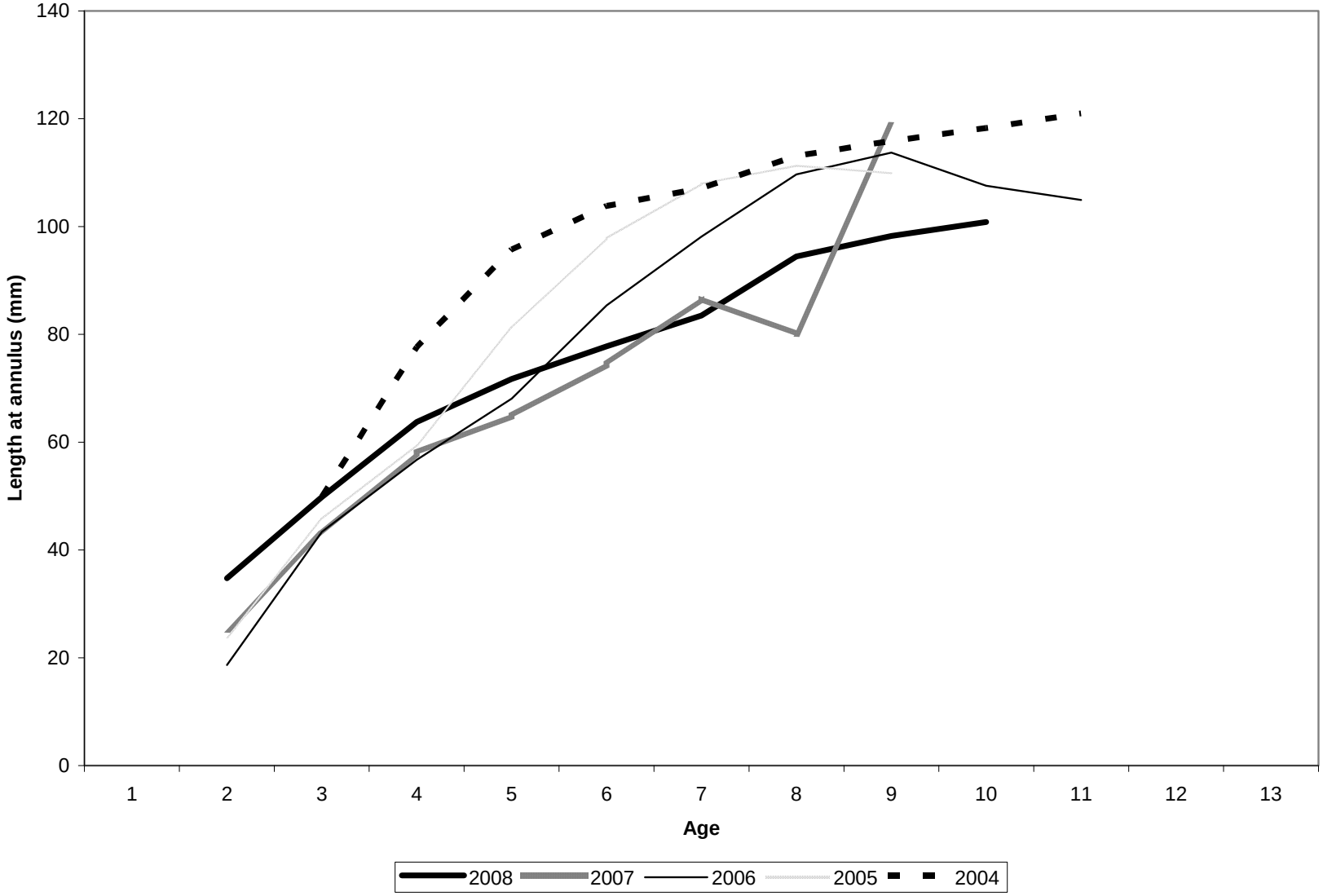

Figure 9.-Length-at-last-annulus formation for razor clams at Clam Gulch Beach, 2004-2008.

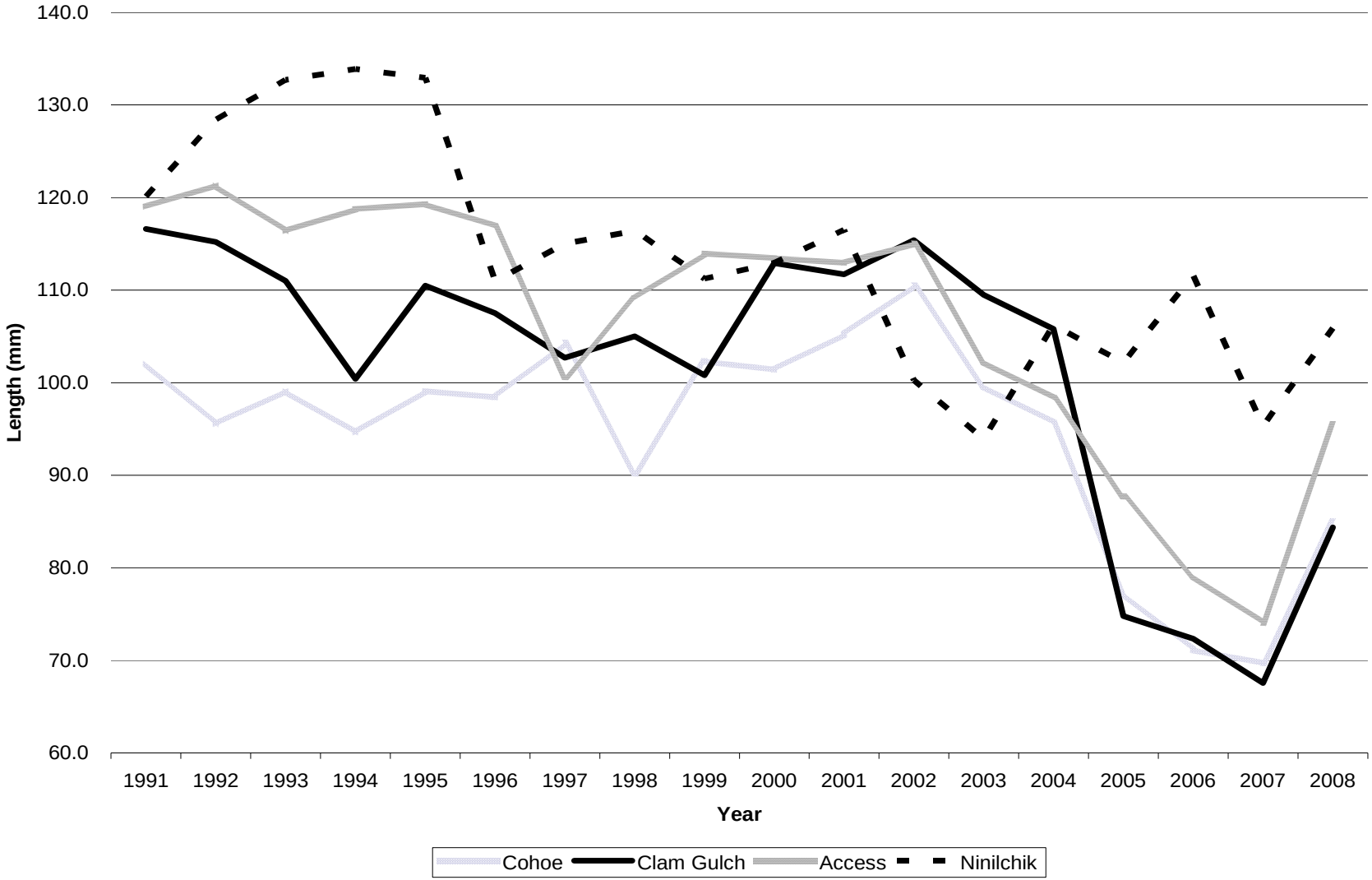

Figure 10.-Average length of razor clams from selected eastside Cook Inlet beaches, 1991-2008.

APPENDIX A. DATA FILES

Appendix A1.–Percentage of razor clams sampled at Clam Gulch Beach by age class, 1969-2008.

Year	Age Class														Number Sampled
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1969		2.4	5.8	13.6	5.4	36.5	36.3								742
1970			4.1	17.1	15.9	30.5	32.4								655
1971			0.9	28.8	17.6	29.0	20.2	3.5							688
1972				8.4	45.9	19.8	11.5	14.4							715
1973			1.5	2.4	8.6	52.4	23.3	9.2	2.6						824
1974			0.2	1.5	2.3	12.3	43.5	28.3	10.0	1.9					480
1975			0.4	0.6	4.2	5.0	18.6	42.9	19.2	9.1					504
1976				0.4	1.0	7.4	5.9	9.8	14.1	19.9	41.5				744
1977			1.1	3.0	2.0	4.5	5.9	8.8	28.9	45.8					433
1978				1.4	6.1	6.9	8.0	9.6	28.1	39.9					492
1979			0.2	1.5	5.3	5.3	9.5	11.2	30.0	30.0	6.2	0.8			546
1980		0.3	12.4	0.9	5.7	3.4	11.8	12.6	14.9	29.9	7.2	0.9			348
1981			0.4	30.9	14.3	8.5	10.0	7.7	5.8	17.4	4.2	0.8			260
1982		1.5	1.0	23.0	25.5	14.2	10.8	5.9	7.8	8.8	1.0	0.5			204
1983			4.3	5.1	16.3	36.8	17.9	6.8	2.6	7.6	1.7	0.9			116
1984		1.3	2.8	8.7	14.6	10.0	42.6	9.3	6.0	4.0		0.7			150
1985			3.1	7.7	9.2	6.2	30.8	16.9	6.2	12.3	4.6	1.5		1.5	65
1986			4.2	3.2	41.5	8.5	9.6	29.8	2.1	1.1					94
1987			19.3	3.7	18.3	38.6	12.8	6.4	0.9						109
1988				11.6	18.2	42.1	14.9	9.9	3.3						122
1989			2.7	10.7	2.7	24.1	21.4	18.8	11.6	8.0					112
1990	7.7	1.9	5.2	3.2	7.1	5.2	18.1	36.8	11.6	3.2					155
1991			5.3	7.3	5.6	7.6	10.6	32.3	22.1	9.2					303
1992			0.6	29.8	10.2	9.1	4.4	12.3	14.3	17.3	1.5	0.6			342
1993		1.0	0.8	0.8	53.8	9.4	2.9	6.0	12.1	10.8	2.1	0.3			381
1994		4.7	1.2	8.3	52.8	13.7	3.8	4.5	5.2	4.7	0.7	0.5			424
1995			6.7	1.0	24.4	32.7	7.3	9.5	11.7	5.1	1.3	0.3			315
1996		3.2	2.3	22.2	17.8	23.7	15.5	8.8	4.4	1.8	0.3				342
1997		0.8	22.0	12.6	19.8	19.5	17.0	4.1	3.3	0.8					364
1998		3.3	7.9	47.5	6.6	12.5	11.5	5.9	4.6	0.3					305
1999			3.0	58.7	18.3	12.7	3.3	3.7	0.3						300
2000		0.6	0.3	3.8	14.6	23.1	14.9	18.0	12.0	8.9	3.2	0.6			316
2001			0.7	4.4	5.4	15.2	31.3	16.8	13.5	8.8	3.7	0.3			297
2002			0.7	6.5	5.5	11.0	15.8	34.7	11.3	8.6	5.8				291
2003			1.0	10.6	16.3	17.3	15.6	24.9	9.0	4.0	1.0	0.3			301
2004			1.3	8.9	16.5	20.1	13.2	27.1	10.2	2.0	0.7				303
2005		5.7	7.7	47.5	20.1	4.0	6.4	3.3	5.4						299
2006		0.7	10.3	4.3	60.9	15.3	7.1	0.4	0.4	0.4	0.4				281
2007		1.0	14.5	21.0	4.8	54.5	2.3	1.6	0.3						310
2008		2.6	11.5	35.8	19.5	1.3	25.9	2.9	0.3	0.3					313

Appendix A2.–Percentage of razor clams sampled at Ninilchik Beach by age class, 1974, and 1977–2008.

Year	Age Class													Number Sampled
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1974			1.3	1.3	1.3	43.0	21.5	22.2	9.4					149
1977					6.4	3.2	1.6	24.2	32.3	11.3	21.0			62
1978						12.5			37.5	12.5	25.0	12.5		8
1979														
1980			90.0	7.5	2.5									80
1981														
1982			7.5	5.0	3.1	79.5	1.2			2.5		1.2		161
1983		7.9	21.2	46.3	4.0	4.0	16.6							151
1984		1.4	63.0	27.4	6.8	1.4								73
1985		0.0	5.9	69.4	11.8	4.7	3.5	2.4	2.4					85
1986		0.0	3.4	3.4	48.9	34.1	3.4	5.7		1.1				88
1987			9.9	6.6	2.2	57.1	18.7	4.4	1.1	0.0				
1988														91
1989	3.3	4.7	0.7	7.3	16.0	6.0	1.3	21.3	24.0	9.3	4.0	1.3	0.7	150
1990		10.0	27.3	9.1	0.9	0.9	12.7	19.1	8.2	8.2	3.6			110
1991		1.7	81.7	12.5				2.5		0.8	0.8			120
1992		2.1	0.8	73.2	9.2	1.3	1.3	3.8	2.9	4.2	0.8	0.4		239
1993		1.0	13.3	5.5	47.8	24.6	3.1	1.0	1.4	1.0	1.0	0.3		293
1994		0.3	2.7	17.6	12.2	55.1	8.4	0.8	1.6	0.8	0.3	0.3		370
1995		1.6	6.2	15.8	26.4	41.0	5.6	0.6	1.6	0.9	0.0	0.3		322
1996		40.2	5.6	8.5	19.9	21.7	2.1	1.5	0.3	0.3	0.0			341
1997		0.3	40.5	16.0	10.8	10.8	13.7	4.6	1.6	1.3	0.3			306
1998		5.6	8.9	57.2	5.6	8.6	7.2	5.9	1.0	0.0				304
1999		24.8	13.9	6.6	41.1	4.3	3.0	5.0	1.3	0.0				302
2000		5.0	58.8	9.4	4.4	15.4	3.8	0.9	0.9	0.6	0.3	0.3		318
2001		5.3	8.3	38.0	22.0	5.3	15.0	2.7	1.7	0.3	0.7	0.3	0.3	300
2002	11.0	36.7	12.3	3.9	25.6	3.6	1.6	2.6	1.0	0.6	0.3	0.3	0.3	308
2003		56.6	18.4	8.9	4.3	5.3	2.6	2.3	1.0	0.3	0.3			304
2004		1.0	54.5	15.7	8.4	8.7	7.4	2.3	1.3	0.3	0.3		0.3	299
2005	1.0	23.1	7.7	49.8	7.4	2.0	4.3	1.7	1.0	0.7	0.7	0.7		299
2006		1.3	23.3	8.5	53.1	7.5	3.0	2.6	0.3	0.3				305
2007		20.9	17.4	38.0	8.1	14.2	1.4							345
2008		8.1	42.7	19.3	18.7	1.9	9.0		0.3					321

Appendix A3.-Percentage of razor clams sampled at Oil Pad and Set Net accesses combined by age class, 1985-2008.

Year	Age Class 1	2	3	4	5	6	7	8	9	10	11	12	Number Sampled
1985			22.9	11.8	24.8	20.3	11.1	7.8	1.3				153
1986	1.9	6.3	16.9	23.1	26.3	12.5	6.3	4.4	2.5				160
1987			4.8	23.5	29.5	27.7	10.2	4.2					166
1988													
1989	1.8	10.0	32.7	1.8	12.7	1.8	27.3	10.0	1.8				220
1990		11.4	10.2	11.4	3.1	10.6	10.6	26.8	12.6	3.1			254
1991		0.4	9.7	21.5	14.7	4.3	9.3	19.0	11.8	6.1	2.5	0.7	279
1992		0.3	1.4	45.1	14.4	6.3	2.6	14.4	10.6	4.3	0.6		348
1993		0.2	13.5	3.9	51.3	11.4	3.4	7.1	4.3	3.6	1.1	0.2	466
1994		0.2	1.5	5.4	63.8	15.1	3.2	4.3	4.7	1.3	0.6		536
1995		1.6	8.7	3.7	35.4	37.3	5.8	4.5	1.9	0.8	0.3		378
1996		4.8	3.5	18.0	27.3	31.5	9.0	3.5	1.6	0.6			311
1997		0.3	62.1	5.5	21.0	4.7	4.7	0.9	0.9				343
1998		0.7	3.9	78.1	9.8	4.9	1.6	0.7	0.3				306
1999		0.7	9.9	62.7	13.9	9.2	3.3	0.3					303
2000		0.3	8.1	6.6	12.1	45.2	17.9	6.3	2.6	0.9	0.0		347
2001	0.6	4.9	4.5	7.8	12.3	16.9	42.5	7.8	1.6	0.6	0.3		308
2002	3.9	9.8	8.1	8.8	14.7	15.6	18.6	16.3	3.6	0.7			307
2003		12.4	25.8	15.7	6.5	15.0	8.8	9.2	5.6	1.0			306
2004			43.9	14.5	10.2	7.9	9.6	8.6	5.3				303
2005		5.2	10.0	70.6	11.8	1.4	1.0						289
2006		8.4	44.0	6.4	37.2	3.4	0.7						298
2007		20.7	21.7	37.9	8.4	10.4	1.0						309
2008		8.6	40.6	22.4	24.1	1.0	3.0	0.3					303

Appendix A4.–Percentage of razor clams sampled at Cohoe Beach by age class, 1985-2008.

Year	Age Class												Number Sampled
	1	2	3	4	5	6	7	8	9	10	11	12	
1985			15.0	32.0	36.0	7.0	8.0	2.0					100
1986			0.0	68.4	16.3	9.2		5.1	1.0				98
1987			10.1		69.7	14.1	3.0	3.0					99
1988													
1989			23.3	6.8	8.7	13.6	22.3	22.3	2.9				103
1990		8.5	5.4	69.8	2.3	1.6	9.3	0.8	0.8	0.8	0.8		129
1991		0.9	37.4	44.3	5.2	1.7	3.5	2.6	3.5	0.9			115
1992		0.7	4.4	70.8	19.7	1.5	2.2	0.7					137
1993			19.0	6.3	50.0	18.3	2.1	0.7	2.8	0.7			142
1994		0.5	1.4	30.6	59.7	7.9							216
1995		0.6	17.8	9.2	33.9	29.3	4.6	2.3	2.3				174
1996			0.6	59.4	25.5	10.9	3.6						165
1997			31.7	9.0	31.7	20.0	4.8	2.8					145
1998		24.2	5.9	46.4	7.2	7.8	5.2	3.3					153
1999			7.2	51.0	13.7	11.1	6.5	6.5	2.6	1.3			153
2000		9.9	2.5	8.7	16.1	29.8	20.5	7.5	4.3	0.6			161
2001		0.0	7.9	2.6	16.6	6.0	52.3	9.3	3.3	2.0			151
2002		0.0	0.0	6.9	9.4	5.0	19.5	12.6	34.0	7.5	4.4	0.6	159
2003		0.7	13.8	24.1	11.7	9.0	15.2	16.6	5.5	2.8	0.7		145
2004			3.3	35.5	30.9	9.9	11.2	7.2	2.0				152
2005			2.0	80.0	14.0	2.7	1.3						150
2006		0.6	25.9	10.1	48.7	14.6							158
2007			33.8	37.6	8.3	18.5	1.9						157
2008		2.5	20.6	56.9	16.9	0.6	2.5						160